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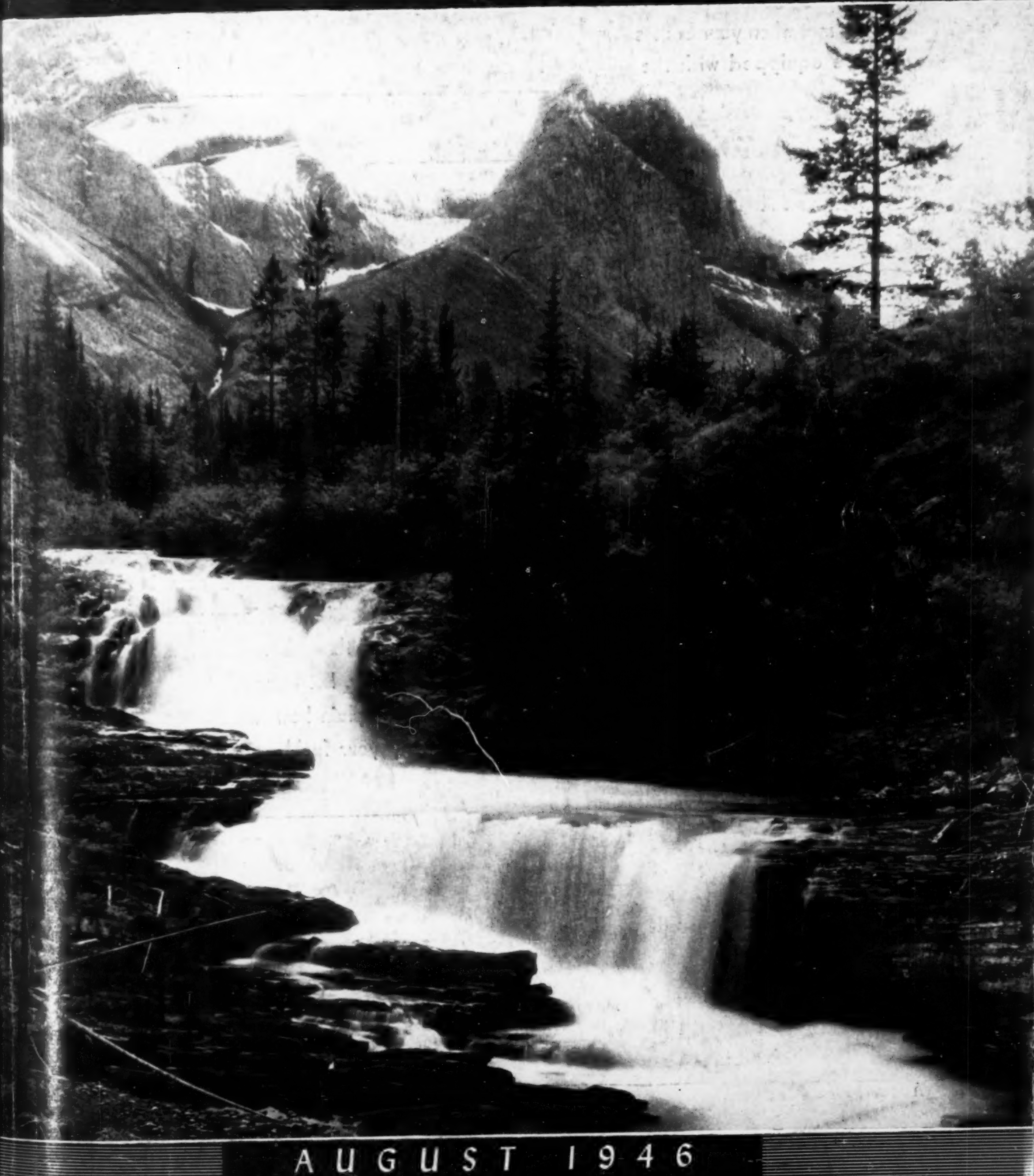

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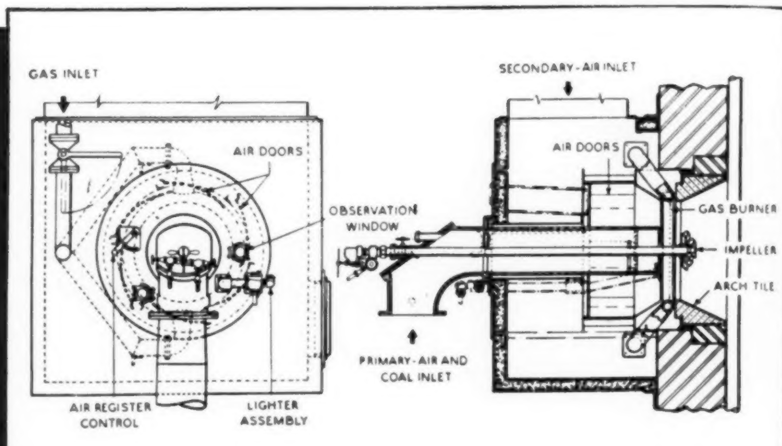

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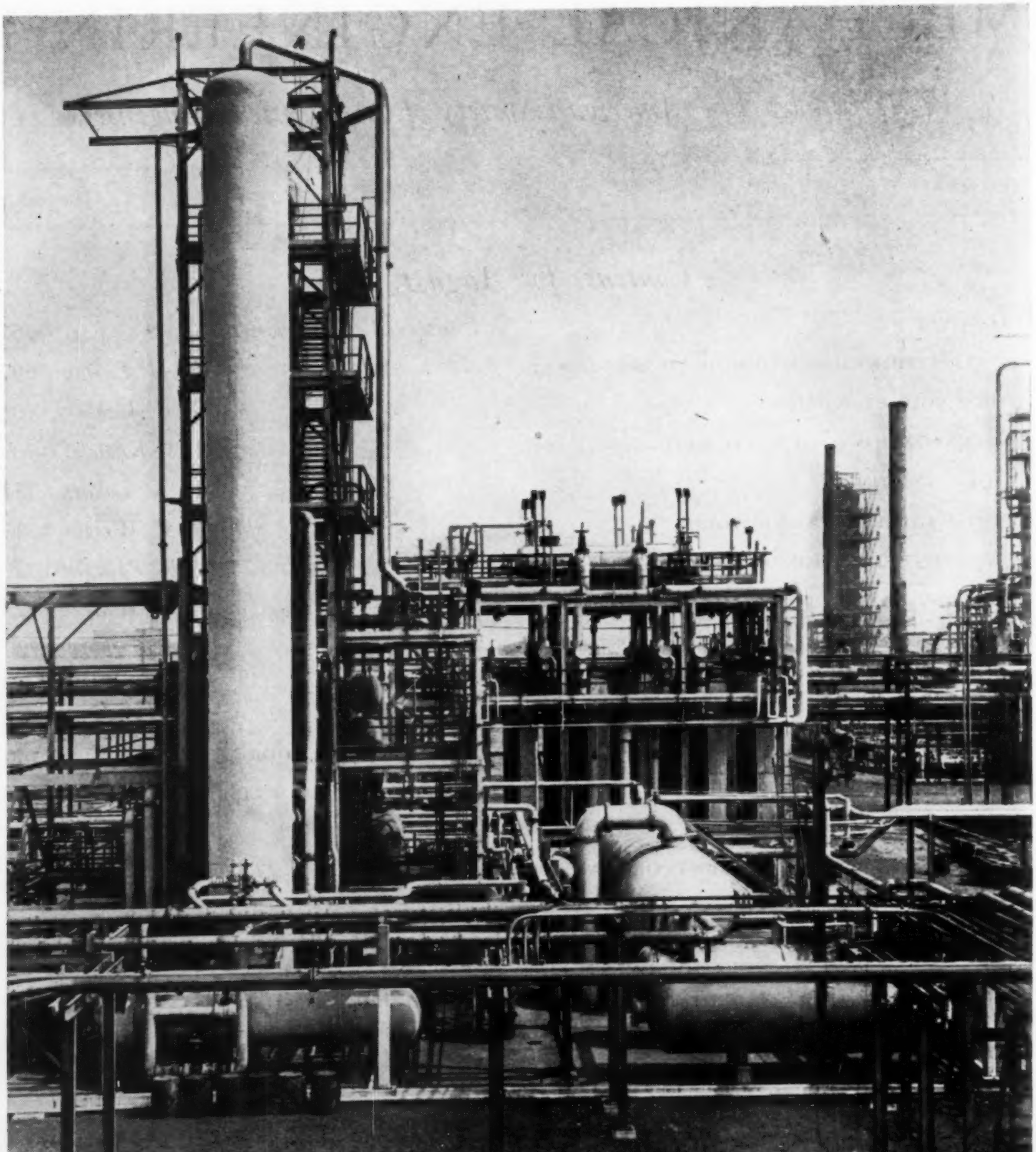

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Volume 68
No. 8

MECHANICAL ENGINEERING

August
1946

GEORGE A. STETSON, *Editor*

Creative Imagination

TO the considerable number of articles in the general field of creative engineering that have appeared in Mechanical Engineering and are available in pamphlet form, we are fortunate in being able to add another in this issue under the title "Creative Thinking and How to Develop It." In this article the author, who died shortly after submitting it and who was a writer, not an engineer, has analyzed in layman's language the arduous processes of creative thinking. Engineers who have engaged in creative work, whether it be invention, development, research, or just writing, will recognize Mr. Easton's description of moods, methods, and mental processes and will probably agree that the creative processes of imagination, inspiration, and illumination attend his success in the order named, regardless of whether the field be science, invention, or the arts. Creative thinking is involved, regardless of the subject. Hence the observations of a man whose thinking was done in the field of literary expression should be valid and helpful to one whose field is invention or engineering development.

Coincidentally there has recently appeared (*The Scientific Monthly*, June, 1946) an article entitled "The Biological Basis of Imagination," by R. W. Gerard, of the department of physiology, The University of Chicago, in which further light is shed on creative imagination and numerous examples of it are described. Creative imagination, according to Gerard, "is an action of the mind that produces a new idea or insight." Again, he says, "Imagination supplies the premises and asks the questions from which reason grinds out the conclusions as a calculating machine supplies answers."

Further paralleling some of Mr. Easton's observations, the following quotations from Gerard's article are of interest.

"Many have insisted that the imaginative process is different in art and in science. I see no basis for such a position. On the contrary, the creative act of the mind is alike in both cases. . . . . Rather, the criteria for sifting may differ. Both art and science demand meaningful relations; but the one is satisfied more by pleasing structure, the other by logical validity.

"Imagination re-enters at all stages of intellectual endeavor, it does not merely deliver a mental foundling to the care of other faculties of the mind. In science, as an example, imagination enters into the devising of experiments or of apparatus or of mathematical manipulation and into the interpretation of the results so obtained. But these are likely to be minor miracles compared with the major insight achieved in the initial working hypothesis.

"Imagination is not encompassed in reason. True, reason gives 'the truths no mind is free to reject,' and logic is an index, through function, of how the brain machine is constructed. But logic can never reveal all the laws of thought. . . . ."

Much of Gerard's article is devoted to the scientific aspects of his subject, limited by lack of complete knowledge owing to the current status of research in that field. His concluding comments include some statements pertinent to the efforts of engineers to stimulate creative imagination. "Formal education," he says, "is directed to our conscious reason, which can at least be supplied with content and practice; if the more intuitive and unconscious imagination can be cultivated we have yet to learn the secret. . . . To teach rigor while preserving imagination is an unsolved challenge to education."

The Rational Life

IF the war interrupted the progress of pure science, it also afforded men of science opportunity to work in the fields of applied science, technology, and engineering, where demand for trained manpower greatly exceeded the supply and thus enriched those fields immeasurably. Today as never before laymen hold applied science, technology, and engineering in high regard because they have witnessed the powerful influences on their lives which originate in these areas of human knowledge and are conscious of many of the social, economic, and political problems raised by these influences. The scientists themselves have also gained a more acute appreciation of these influences because of their close relationship during the war to the developments that flowed from discoveries in the field of pure science. Hence they have become concerned not only with the immediate problem of the place of technology in society, but also its more specialized corollary of the place of pure science in society.

A discussion of this question of science in society is to be found in an article by E. F. Caldin, scientist and philosopher, in the April, 1946, issue of *Endeavour*, a "quarterly review designed to record the progress of the sciences in the service of mankind," published by the Imperial Chemical Industries, London, to which it has long been our intention to direct the attention of engineers. Mr. Caldin takes pains to distinguish between science, applied science, and technology. He asserts that

"much of the current writing on the place of science in the postwar world is really about technology, with science considered only as a part of the necessary basis for it." Although he is concerned with the "social functions" of science as distinguished from technology, his concept of scientific life as one version of rational life can be carried over into engineering with helpful effects.

Mr. Caldin's thesis is that "life is a unity; the scientific part of life affects the rest; a scientist becomes in and through his scientific work, a better man or a worse, and his influence on his fellow men is correspondingly helpful or harmful." The key to the integration of science and the rest of the scientist's life is that "scientific life is a version of rational life, an adaptation to a particular activity of the principle common to all rational life; consequently, if rightly lived, it should develop those qualities which make rational living possible in other departments of life. Scientific life is a type of life lived according to right reason."

The six principles of scientific life are, to summarize Mr. Caldin's enumeration, the following: Scientific life demands the experiences of the senses; it demands that observation shall be interpreted by reason; it is characterized by a continual interplay of experiment and theory; it is a developing tradition; it requires freedom; and it is a social as well as a personal enterprise.

Having spoken as a scientist up to this point, Mr. Caldin next speaks as a philosopher; and here extended quotation will be helpful:

"All the six general principles named," he says, "belong also to other studies and indeed to any rationally conducted enterprise, from philosophical research to farming. Every student can recognize in them the principles of his own speciality. But in pursuing natural science we use a special adaptation of those principles, a particular version of rational method. Historians use another version, philosophers yet another; craftsmen, businessmen, housewives, all have their own special rational habits adapted to the work in hand. The method of natural science is not the sole and universal rational way of reading truth; it is one version of rational method adapted to a particular set of truths. The point needs emphasizing, both to point out a common mistake and to show how to correct it. Large numbers of people have been misled into thinking that the procedure of natural science is the royal road to truth in every field; that what cannot be proved by science cannot be true; and that metaphysical propositions, for example, are meaningless or at any rate unprovable. The mistake here lies in confusing the part with the whole—scientific method with rational method. But we can substitute an important truth for a mistake if, agreeing that science is not to be divorced from other rational pursuits, we find their connection in this: that science is not only a version but a microcosm of rational life. By this is meant that in studying science and becoming familiar with that form of rational activity, one is led to understand rational life in general: one grasps the principles of all rational procedure through practice of one form of it. It should then be easier to adapt those principles to other studies and to life in general. Scientific work, in short, should be a school of rational life."

This is inspiring doctrine, although it places on everyone, particularly engineers whose work combines applications of natural science, economic considerations, and the problems of human behavior, the necessity of devotion to "right reason" under frequently confusing circumstances. "We need," as Mr. Caldin says, "a survey which will show exactly how the diverse methods of the various rational disciplines are all versions of the general method of reason working on experience, and yet are all legitimately different. . . . . Endless confusion would be saved if it were more widely realized that natural science is restricted, by its very method, to the study of a limited field from a particular angle. . . . . Scientific life can be a microcosm of rational life, but it cannot claim to be the macrocosm."

Let engineers take to heart as much of this philosophy of the rational life as they can apply to themselves and their work. From their practice, particularly in industrial establishments, engineers have recognized for several years that, to paraphrase Mr. Caldin, engineering life can be a microcosm of rational life, but it cannot claim to be the macrocosm. Liberalization of the curricula of engineering schools is a recent example of this recognition. It is an admission of the fact that certain nonengineering disciplines are important to the development of a satisfying life and essential to the discharge of the obligations of the engineer's career. From a narrowly technical and vocational type of education, engineering education is destined to emerge as a general training for the rational life of today with particular adaptation to the industrial environment.

Many persons feel that liberal-arts curricula compare unfavorably with engineering curricula not only in the training for competence in a useful career but also in the integration of the fields of knowledge studied. But it will not do for engineering schools to assume that they have any permanent advantage in these particulars, for the liberal-arts colleges are reviewing and revising their educational programs with a view to attaining in them greater breadth and depth and better integration of subject matter. These more purposeful programs of study, conducted so as to develop the mature intellectual stature of the student, are likely to attract men who have capacity for leadership and public service. If the engineering schools are to secure their fair proportion of men of this type, they must continue unabated their efforts to educate men for the engineering version of the rational life.

Paper Shortage

DURING the war more than 3000 A.S.M.E. members gave up Transactions and *Journal of Applied Mechanics* so the Society would have enough paper for its monthly publications. Today paper is still in short supply and another appeal will be issued shortly. A generous response is hoped for, particularly from members in organizations where several copies are normally received.

CREATIVE THINKING *and* HOW *to* DEVELOP IT

By WILLIAM H. EASTON

Few human abilities play a greater role in engineering progress than the skilled ingenuity and creative thinking which underlie both inventiveness and resourceful leadership.

Because of their belief in the importance of creative thinking in engineering and in the extent of the influence of college and industry in cultivating it or withering it, the Committee on Education and Training for the Industries of The American Society of Mechanical Engineers arranged for the presentation at the 1942 and 1943 Annual Meetings of a series of papers on various aspects of this problem. These papers aroused such widespread interest that they were collected and republished in 1944 in a pamphlet entitled "Creative Engineering."

These papers analyzed creative engineering thinking, gave examples of it, and discussed what colleges and industry could do to foster it. They left for later discussion, however, the handling of the difficult questions of what an individual can do to use his creative powers most effectively when faced with a concrete problem, and to develop in himself the art of creative thinking. These questions are ably dealt with in the article, "Creative Thinking," by William H. Easton, which thus rounds out the series of discussions.

To give practical advice in regard to inventive and creative thinking is peculiarly difficult because such thinking is so individual and intuitive as to be utterly incompatible with any precise order or routine. Mr. Easton, however, has made both his analysis of this problem and and his advice so fundamental as to free them completely from routine and to make them applicable to everyone whose work involves creative originality in any field. Yet he has written so clearly, simply, and concretely that the reader has no difficulty in understanding how the advice applies to himself and how to put it into practical use.

It is sad that Mr. Easton, after bringing years of analytical observation and thought to this fruition, died between the time when this article was written and the time when it could be published, and cannot receive the recognition that will be accorded to his labors. For his article will be of great value to all whose present work or future advancement involves opportunities for creative thought, and to all executives or educators who are in a position to assist young men to cultivate their creative gifts and to develop the art of creative thinking.—Elliott Dunlap Smith

THE object of this article is to assist inventors, scientists, writers, public speakers, artists, composers, and others doing original work in the more efficient use of their creative mental machinery.

If the reader expects to be shown how to think creatively without hard labor, he will be disappointed. On the contrary, almost every phase of creative thinking calls for intense mental effort. What I have tried to do is to indicate how this effort can be applied to the best advantage.

The discussion throughout is from the standpoint of the reader who is not concerned with psychology. The creative mental processes as here defined are practical concepts; whatever they may be psychologically, they are, for the man who makes a living with their aid, what the hammer, the chisel, and the saw are for the carpenter.[1]

I—CREATIVE THINKING

Ever since man first became man, people with a talent for original thought have played decisive parts in advancing human progress.

Back in the Old Stone Age, such people laid the foundations of the arts and the sciences. They introduced the use of fire, invented weapons and tools, designed decorative motifs for articles of daily use, painted lifelike pictures of animals on cavern walls, and told stories that, in the form of myths and fairy tales, are still being told all over the world. Doubtless, too, they exercised their mental ingenuity in many other ways that have left no traces.

But they were few and far between. The vast majority of our paleolithic ancestors never originated anything. Throughout periods lasting for centuries, as the record shows, they made no change whatever in their way of living or the artifacts they produced.

This uncreativeness was not due to a lack of intelligence. Once shown how to make and use an invention, these ancient people could become expert in the often complicated techniques involved. But the vast majority were unable to think out new ways of doing things; only the more highly gifted could do that.

Today we are far more progressive because we have many more innovators in every field of human endeavor. But the general situation is not greatly altered. Most people in modern society do only what others have done before them, and, if they have original ideas, they fail to develop them. All really new things of importance are still being produced by a relatively small number of exceptional individuals.

We shall call these exceptional individuals "creative thinkers" and the mental processes that enable them to produce new things "creative thinking."

CREATIVE THINKERS

It is probable that creative thinkers are born, not made. Some people want to think creatively while others do not. Education can, of course, help to develop latent powers, but it is not a vital factor. Many highly trained persons are sterile creatively, while others (like Edison) accomplish outstanding results in spite of an almost total lack of formal instruction.

But what traits are essential for genuine achievement in creative thinking? With the aid of data derived from a study by Walter B. Pitkin,[2] we can draw up a list that will be useful

The author of this article died shortly after he had submitted it.—Editor.

[1] Those who wish for further information on creative thinking are advised to read the publications by John Dewey, Elliott Dunlap Smith, and Jacques Hadamard referred to in the article. The first is a study of deliberate thinking; the other two deal with creative processes.

To avoid possible confusion, I must point out that in a series of articles for *The Writer* (March, 1941; March, 1942; July, 1942) I used names for some of the creative mental processes that differ from those used here.

[2] "Psychology of Achievement," by Walter B. Pitkin, Simon and Schuster, New York, N. Y., 1930.

for self-analysis or for appraising the capabilities of others.

The creative thinker must have ambition, for a clear and powerful urge to accomplish something notable is the mainspring of all creative endeavor.

When he meets with the difficulties that inevitably arise in the course of his work, he must persist in struggling with them until he has overcome them, no matter how long it may take. For this he requires both energy great enough to sustain him in the most arduous kind of mental labor and also complete confidence in his ability to attain final success.

As the scope of his creative work depends upon his store of knowledge, he should be constantly engaged in enlarging this store by study, experiment, and observation. He must therefore have a high capacity for self-instruction.

He must have enthusiasm, devotions, passions. Creative thinking is not a purely intellectual process; on the contrary, the thinker is dominated by his emotions from the start to the finish of his work.

He must possess an inquiring mind, and above all, a creative imagination.

The importance of these traits will become amply clear as we study the work of the creative thinker.

THE TOOLS OF THE CREATIVE THINKER

This work is the subject which will engage our attention from now on. We shall consider how the creative thinker goes about bringing new things into existence, what obstacles he is likely to encounter, and what he can do to surmount these obstacles. In other words, we shall try to find out how he can make good use of the mental tools of his trade.

It is probably the general impression that these tools are of many different kinds, some being used by wrtiers, others by composers, still others by inventors, and so on. But this is not the case. There is only a single set, which is used by every creative thinker regardless of his line of work.

Woodworkers furnish us with a rough analogy. These men employ only a few simple implements, but with their aid they can turn out an unlimited variety of products, ranging from crude articles of utility to works of the highest artistic excellence. The differences in individual output depend upon differences in the native ability and acquired skill of the workers, their objectives, and the raw materials available to them.

The use of the same mental equipment for all purposes explains why a man like Leonardo da Vinci could be, alternately, a painter, a sculptor, a musician, a scientist, an inventor, and an engineer. He employed identical methods of thinking in each capacity.

There have been many other multisided thinkers, but they are rare these days. It is becoming increasingly difficult to gain a mastery of more than one subject, so that most people, after perhaps trying out several different kinds of creative work in their early years, end up by specializing in some one particular line.

We must now turn to what, for many, are the dry bones of our study—the tools that the creative thinker uses.

Most people have little interest in their mental processes. They merely take them for granted and use them as a child uses its muscles—without the slightest regard for the mechanisms involved.

This attitude is well enough for the average individual; but if the creative thinker wishes to become an efficient workman he must know his tools and understand their uses. Hence it is necessary to take a look at the contents of his toolbox.

There is only a single set of mental processes here, for all are indispensable; but for our purposes we shall divide them into two groups, which we shall call noncreative and creative, respectively.

Chief among *the noncreative mental processes* are the following:

Observation—studying perceived objects and circumstances
Reflection—reviewing the content of the mind.
Remembering—recalling past experiences and previously acquired ideas.
Reasoning—determining the consequences of assumed conditions and courses of action.
Judgment—formulating decisions.

With the aid of these processes the thinker deals with his available supply of raw material. They enable him to collect data from his store of knowledge and from the results of his research; to evaluate each item in terms of his immediate purposes; to select those that are of use to him and to reject the rest; and to organize his selections in some systematic manner

They also enable him to come to certain conclusions as to the significance of his collected material; and finally, they provide him with means for determining the probable validity of these conclusions.

All this is merely a verbose way of saying that the noncreative mental processes form the basis of logical thought and therefore of all sound creative thinking.

As these processes are fully discussed in an extensive literature that is available to everyone, we need not give them further consideration here, except to point out one of their very important limitations—they are incapable of originating what is entirely new.

In the words of Abbot Payson Usher,[3] the noncreative processes are "cold and conservative; without the purpose or the power for great achievement."

Elliott Dunlap Smith,[4] in tracing the steps that led to a typical invention, stresses the fact that the "act of inventiveness which achieved the solution was not logical scientific thought at all;" and he also says that "unless the inventor is willing to relax the meticulous step-by-step procedure of logical science. . . .he will get nowhere."

Hence for the highly special tools used by the creative thinker, the ones with which he brings into existence that which did not exist before, we must look to the *creative mental processes*.

Before examining these, however, we must call attention to two points that require explanation.

In the first place, it is commonly said that the innovator "evolves new ideas," but this is a misstatement. He actually evolves new combinations of ideas that are already in his mind. Sometimes these combinations consist wholly of long-known ideas, and sometimes they form around ideas that have just been acquired; but in no case does the thinker create the ideas. They come to him in various groupings and are rearranged by the creative mental processes.

Secondly, though the creative processes are quite unlike in action, results, and controllability, they are seldom clearly differentiated and do not even have generally accepted names. Consequently, they have to be assigned names here that are ordinarily used with somewhat different meanings.

There are three creative processes which are used by every thinker. These are:

Imagination, which is the power that enables a thinker to weave ideas into new combinations while he is engaged in deliberate thinking. It usually deals with easily remembered ideas.

Inspiration, which is the result of an accidental stimulus.

[3] "History of Mechanical Inventions," by Abbot Payson Usher, McGraw-Hill Book Inc., New York, N. Y., 1929.

[4] "Some Psychological Factors Favoring Industrial Inventiveness," by Elliott Dunlap Smith, MECHANICAL ENGINEERING, March, 1944, pp. 159–162.

It occurs when new ideas derived from some observed object or circumstance suddenly and automatically combine with old ideas.

Illumination, which is evoked by intense deliberate thinking and forms new combinations of ideas after the thinking has ceased. It resembles inspiration in occurring without present effort, but has an entirely different cause. It frequently brings to the surface long-forgotten ideas.

In addition to these three processes there may be others. Thinkers of all lands and of all times have claimed that ideas have come to them through such media as intuitive insight, visions, and communications from the spirit world.

Many of these manifestations can probably be referred to the listed processes, which not infrequently operate so dramatically and unexpectedly as to favor a mystical explanation of the results; but in some cases, creative powers of a different order may be involved. If so, these powers act sporadically and unpredictably and have no place in a discussion of normal creative thinking.

THE USE OF THE CREATIVE MENTAL PROCESSES

The creative thinker differs from other people, not in using the creative mental processes, but in the way he uses them.

Everyone employs these processes for building castles in the air, for worrying about anticipated evil, and for devising methods of escaping from trouble. But such excursions into the creative field are about all the average individual undertakes, and he rarely undertakes these intentionally. For him, creative thinking is either a matter of drifting into idle flights of fancy or of engaging in disagreeable mental labor under the pressure of necessity. As a rule, he does as little of it as possible.

The creative thinker, on the other hand, uses the creative processes deliberately, purposefully, and for definitely selected ends. In particular, he enjoys using them and, proverbially, will sacrifice much for opportunities to do so. Thus he stands quite apart from the noncreative majority. He is not necessarily more intelligent than his fellows; he simply has a different temperament.

The actual use of the creative processes is instinctive; no one needs to be told how to exercise his imagination or what to do when inspiration occurs. But the efficient use of these processes is a different matter.

Efficiency in creative thinking consists in carrying on creative work to a successful conclusion with a minimum expenditure of time, mental effort, and nervous energy. It is a subject that so far has been given littlea ttention by thinkers, but there are probably few who cannot do better work by using their mental tools more efficiently.

To utilize the creative processes efficiently, one must know:

- What process will be employed under given circumstances.
- What are the capabilities and limitations of each process.
- What conditions favor and what conditions inhibit the activity of each process.
- How each process can be controlled, in so far as this is possible.

These matters now require consideration.

II—IMAGINATION AND DELIBERATE CREATIVE THINKING

In what may be called the deliberate type of creative thinking, one starts with a more or less clearly defined objective and then takes steps that will lead to its attainment.

These steps will necessarily vary with circumstances; but in all cases, one of the first is to use the imagination to construct, out of data supplied by memory and observation, a framework of ideas that will serve as a foundation for further work.

Thus the writer uses imagination to outline the composition he will write. The artist uses it to transform the model or the landscape before him into the picture he will paint. The inventor uses it to determine the details of the device he is developing. The scientist uses it to draw inferences that will form the basis of a hypothesis.

Imagination builds the framework, but its operations are closely supervised by reason. Reason inspects each proposed idea and passes upon its suitability for the end in view. If reason is satisfied, the idea is retained; if not, the idea is dropped, and imagination hunts around for something better.

Without imagination, there would be no framework, and the thinker would never get started on his project; but without the guidance of reason, the result would be mere fantasy.

This co-operation between imagination and reason in the preliminary stages of creative work is clearly seen in Robert Louis Stevenson's account of "The Genesis of the Master of Ballantrae."

On a cold, clear night, Stevenson was walking on the verandah of his house near Saranac, after he had finished reading Marryat's "Phantom Ship." The story stirred his imagination, and he decided that he, too, would make a tale "of many years and countries, of the sea and the land, savagery and civilization." As he turned the idea over in his mind, the case of a buried and resuscitated fakir occurred to him.

> The next moment I had seen the circumstances transplanted from India and the tropics to the Adirondack wilderness and the stringent cold of the Canadian border. Here, then, almost before I had begun my story I had two countries, two of the ends of the earth involved; and then though the notion of a resuscitated man failed entirely on the ground of general acceptance, or even (as I have since found) acceptability, it fitted at once with my design of a tale of many lands, and this decided me to consider further its possibilities.
>
> The man who should thus be buried was the first question; a good man, whose return to life would be hailed by the reader and the other characters with gladness? This entrenched upon the Christian picture and was dismissed. If the idea was to be of any use at all for me, I had to create a kind of evil genius to his friends and family, take him through many disappearances, and make this final restoration from the pit of death, in the icy American wilderness, the last and grimmest of the series.

Here we have a typical case of deliberate creative thinking. It forms the first step in the creation of a story but a thinker in any other field would work along similar lines.

This is true even though it is often said that the creative work of the scientist is fundamentally different from that of the writer or artist, because the former must be sure that the products of his imagination accord with the facts whereas the latter's fancies are untrammeled.

The difference, however, is more apparent than real. Every intelligent worker in the field of art develops ideas for a definite purpose—to arouse specific emotions in his readers, spectators, or audience. Hence he too must test the products of his imagination for their value before accepting them as parts of his finished work. This he does by noting the emotional reactions they cause in himself and in competent critics.

Such tests are much less satisfactory than those the scientist can apply in the course of his work, and as is evident from Stevenson's admission in the passage cited, they sometimes fail. But they are all that are available to the artist, and he uses them as rigorously as the scientist uses his.

The creation of a good work of art is therefore the same in principle as the creation of a sound scientific theory.

THE DEVELOPMENT OF THE WORK

Sometimes the preliminary framework is so complete that the rest of the work is purely mechanical; as when a writer thinks out a short composition in its entirety, or when an inventor visualizes a new device so clearly that he can make a working drawing of it immediately.

Creation, however, is rarely so easy. As a rule, the thinker does not attempt to develop his ideas fully in advance but draws up a plan consisting largely of problems to be dealt with later. Stevenson's outline illustrates this procedure.

Consequently, regardless of the nature of the plan—whether it be for a poem, a statue, or a piece of research—its execution is mainly a matter of solving the problems involved in it.

These problems, taken as a whole, are infinitely varied in character; yet they can be grouped into three well-defined classes, depending upon the mental processes used in handling them.

The simplest of these problems are those that the thinker solves offhand by virtue of his training and with the aid of his imagination. He takes these in his stride; and as long as his work presents nothing else, he can proceed with it easily and without interruption. But as soon as he encounters a problem that resists immediate solution, he has to stop.

This more difficult kind of a problem demands reflection. As Dewey[6] points out, the thinker begins by studying the situation and forming an estimate of the requirments to be met. He then searches his mind for helpful ideas; and, as various suggestions for overcoming the difficulty occur to him, he reasons out the suitability of each.

Finally, a suggestion that seems to fit the case is selected and tried out. If it is successful the thinker is free to go on with his work. If not, the problem must be studied anew, other suggestions must be selected and applied, and, until a satisfactory one is found, the work cannot proceed.

Deliberate thinking, thus employed, may suffice to solve all the problems encountered while carrying on the work; but problems of another class may arise.

These problems call for solutions that lie outside the scope of the thinker's imagination and reasoning power, and he cannot, therefore, solve them by deliberate thinking. But, even so, his position is not necessarily a hopeless one. He still has recourse to another mental process, illumination, which will be discussed in a later section.

THE INDEPENDENCE OF THE IMAGINATION

In noncreative deliberate thinking, such as reasoning, performing mathematical operations, and preparing factual reports, the imagination is prohibited from taking a leading part, for it cannot be permitted to alter any of the data being dealt with.

But in all phases of creative deliberate thinking, the imagination is continuously active; the thinker employs it at every stage of his work.

He cannot, however, always use his imagination when he needs it. It is not like a machine that can be utilized at will; it is more like an able but unreliable servant who works only when he pleases. Sometimes it is ready to do what the thinker wants it to do, and sometimes it isn't.

This independence of the imagination gives every thinker many bad hours. Nothing is more exasperating than to settle down with every intention of working and then find that one's imagination has pressing business elsewhere.

Under these circumstances, creative thinking is impossible. One may try to concentrate on the job in hand, but one's thoughts insist on wandering away from it. They can be dragged back again as often as one wishes, but they are soon busy with something entirely different.

It takes determination to stand this sort of thing for any length of time. Most people, after a few fruitless efforts to keep their minds on their work, become convinced that they are in the wrong mood and quit in disgust.

This inability to work on demand does not occur with noncreative thinking. The clerk can always carry on his routine duties; but the creative thinker is at the mercy of his imagination, and that, in turn, is dominated by his emotional state.

In other words, creative thinking cannot be undertaken in cold blood. The imagination concerns itself only with whatever has the strongest emotional appeal for the thinker at the moment and refuses to deal with anything else.

This does not mean that the thinker should drop work whenever he is not in the proper mood, for that wastes time. Nor does it mean that he should try to force an unwilling mind to function, for that wastes energy.

What it does mean is that, if he wants to get on with his work, he must gain something that he lacks temporarily; namely an overwhelming interest in the job before him.

THE WORKING MOOD

The way in which one gains interest in the uninteresting is well exemplified by the crossword puzzle.

Solving such a puzzle is, in itself, pointless, and few attempt it if they have anything else to do. But in an idle moment, fill in the diagram with the obvious words and then work out a new word from the definitions and the letter sequences. This snaps a trap! Success in solving the little problems arouses interest, which immediately attracts the imagination, and, from then on, all one's mental energy is devoted to the business of finishing the affair.

The same principle applies to arousing interest in one's work. Mere random thinking about it is useless; the attention must be deliberately concentrated on solving some problem connected with it.

It matters not what the problem may be. The writer, for example, may set down various titles for a proposed composition and select the one that seems most appropriate; the scientist may work out a diagram of the apparatus to be used in an experiment; and so on.

Solving one problem reveals another. When this is disposed of, another appears. Continue this process, and sooner or later, by some psychological miracle, the job will become the most interesting thing in the world.

When this happens, the thinker is in the working mood. His imagination, now wholly occupied with the subject in hand, is subject to his will and pours ideas into his mind. His other mental powers co-operate, and he becomes absorbed in his work, oblivious to his surroundings, to distractions, and even to pain.

As he cannot work when he is in any other state of mind, the creative thinker, who wants to be master of his mental machinery, must be able to force himself into the working mood by the process described whenever the need arises.

It is never an easy operation, however, because it demands the deliberate concentration of attention, which is always unpleasant and, to some people, almost intolerable. Nor can it be done quickly if one is deeply interested in some other matter. Sometimes one must struggle for hours or days before the imagination can be gotten under control.

Indeed, many independent writers, artists, and scientists never subject themselves to this ordeal. They engage only in work that interests them, and, if their interest in it fails at any time, they drop it.

[6] "How We Think," by John Dewey, D. C. Heath and Co., New York, N. Y., 1933.

But many creative thinkers have no such easy escape from unattractive labor. These are the people who work on assignments that are not of their own choosing, such as industrial research men, illustrators, advertising men, and others in commercial lines. These people are often given work that does not interest them and may, at times, be positively distasteful; and they must be able to force themselves to become interested in such projects, or they will neglect them indefinitely.

As a matter of fact, if interest were not aroused by anxiety as well as by the pleasurable emotions, much commercial work never would be completed. Let a commercial man neglect a job long enough to become actually worried about it, and he will soon be sufficiently interested to get busy on it. This, however, is not the way of efficient workmanship.

PRESERVING THE WORKING MOOD

Once in the working mood, the thinker will stay in it for the duration of the job, unless something that arouses stronger interest intervenes. Occurrences of this kind are, of course, often beyond control, but, to prevent losing hold of his work, one should, as far as possible, protect his interest in it from competition.

Normal recreations and activities during nonworking hours do not interfere, but anything of importance that grips the imagination should be avoided, especially other lines of creative thinking. To attempt to carry on two creative projects at the same time is like trying to work for two masters. To serve one, the other must be neglected.

Leonardo, for example, engaged in so many different kinds of creative work that he could rarely retain interest in anything long enough to complete it.

This restriction does not apply to noncreative thinking. Thus, a blindfold chess expert can play a dozen games simultaneously, because, as Binet has shown, according to Hadamard,[6] he does not have to think about each move. He is familar with a large number of chess positions and knows what moves to make in each case. But if an opponent works out a combination that is new to him, he must give it his undivided attention or lose the game.

THE CREATIVE THINKER'S WORKING DAY

When engaged in creative thinking, the mind is under a strain. Eventually, the imagination tires, and it takes an effort to think up something new. At this point, it is time to stop. If anything further is attempted, it will be done poorly.

Thinkers, of course, vary widely in mental endurance, but there are few who can profitably devote more than six hours to continuous creative activity. That is the maximum length of the working day for most writers, and many restrict themselves to shorter periods.

Noncreative thinking, which does not call upon the imagination, is another matter, and one can turn to it with relief when wearied with creation. Thinkers should bear this point in mind and so arrange their work that they can fall back on noncreative operations whenever their creative power begins to flag. Phenomenal workers, like Edison, undoubtedly follow this practice.

III—INSPIRATION AND AUTOMATIC CREATIVE THINKING

Not all creative thinking is of the deliberate type discussed in the last chapter. Sometimes the mind will be suddenly thrown into a high degree of creative activity, with no effort on the part of the thinker and, often, with reference to some subject he never thought of before. This kind of thinking is caused by inspiration.

Many outstanding creations in every field of art and science have been due to inspiration.

A storm at sea gave Wagner the basic idea for his opera "The Flying Dutchman." Mendelssohn heard the theme of his "Hebrides Overture" in the lapping of the waves at Fingal's Cave.

To amuse a boy interested in drawing, Robert Louis Stevenson drew a map of an island with intriguing coves and headlands and named it "Treasure Island." "Immediately," he tells us in his Juvenalia, "the characters of the book began to appear in the imaginary trees."

By a not uncommon accident, a bacterial culture plate being prepared by Alexander Fleming became contaminated with a blue-green mold, penicillium. Examining the plate, which was well covered with colonies of bacteria, Fleming noticed that each spot of mold was surrounded by a clear space. This gave him an idea: "The mold must produce something that interferes with the multiplication of bacteria;" and, impelled by this thought, he carried on research that resulted in the isolation of penicillin.

THE CHARACTERISTICS OF INSPIRATION

Inspiration is an agreeable experience. It brings the thinker automatically ideas that are wholly new to him, and what is of equal importance, it arouses an intensity of interest that sets his imagination racing. The inspired thinker does not have to force himself into the working mood. His one desire is to drop everything else and devote himself to developing his new conception.

This experience is a gift of the gods; its occurrence is wholly beyond control and is always unexpected. But one must be prepared for it. "Happy accidents," leading to notable creations, befall only those whose minds are stored with ideas that are ready to crystallize into some concrete arrangement in response to the right kind of stimulus. Others can be exposed to the same stimulus without the slightest effect.

Thus, no layman would have found inspiration in Fleming's culture plate; and, though all bacteriologists frequently handle just such plates in the course of the work, not one, before Fleming, gained a constructive thought from the contamination.

Inspiration is often the result of a discovery, as in Fleming's case, but it is perhaps well to point out that a discovery and the creative thinking that may follow it are quite different things. Fraunhofer, for example, made the important discovery that certain black lines cross the solar spectrum; but he merely announced their existence and positions and created nothing. The creative work that later connected these lines with the chemical elements in the sun was done by Kirchoff.

Though inspiration is uncontrollable, the chances that it will occur can be increased by enlarging the stock of ideas in the mind and by multiplying observations.

Some people deliberately hunt for inspiration as one hunts for game. They go where they are likely to find it; they keep constantly on the alert for it; and they are ready to take advantage of it when they do find it. Typical of those who can profitably follow this practice is the artist who wanders around the country on the lookout for inspiring combinations of form and color; but, in many fields, game is too scarce to make this form of sport worth while.

However, a determined thinker will sometimes decide to seek everywhere in the hope of discovering a stimulus that will give rise to some desired combination of ideas.

As is well known, Charles Goodyear adopted this plan in his attempt to develop a method of producing rubber that would not get soft and sticky in hot weather and hard and brittle in

[6] "The Psychology of Invention in the Mathematical Field," by Jacques Hadamard, Princeton University Press, Princeton, N. J., 1945.

cold weather. After years of effort and privation he achieved success; but countless others have failed in similar undertakings.

If hunting for inspiration is often a waste of time, passively awaiting it always is.

Anthony Trollope, in his Autobiography, expresses himself forcibly on this point. "There are those. . ," he says, "who think that a man who works with his imagination should wait till—inspiration strikes him. When I have heard this doctrine preached, I have scarcely been able to repress my scorn."

It is to be noticed that Trollope's scorn was not directed at inspiration but at waiting for it. This is something he never did. He trained himself in a routine that kept him always in the working mood and enabled him to get up at 5 a.m. every weekday morning and write for two hours with machinelike regularity. He had inspirations and welcomed them, but he never depended upon them.

There are, however, those who habitually depend upon inspiration to incite them to creative activity. Such people dislike the labor involved in deliberate creative thinking and want "bright ideas" to come to them without effort on their part. They may do brilliant things occasionally, but they are certain to be erratic and unreliable producers.

They are also handicapped in another way: Inspiration rarely supplies enough material to finish the job it starts. After the ideas it contributes automatically are exhausted, new ones are usually needed to continue the project; and, if inspiration is the thinker's sole reliance, he is helpless because inspiration cannot be made to repeat.

The starting of many things that are never finished is a sign of the inspiration-controlled thinker.

Hence while the creative thinker who strives for efficiency should seek inspiration in new experiences, his regular working tools should be his controllable mental powers. Otherwise his output is likely to be meager.

IV—ILLUMINATION, THE PROBLEM-SOLVING PROCESS

James Watt's condenser for the Newcomen steam engine was one of the greatest inventions of modern times. It was merely an accessory for an already developed machine (he did not invent the engine itself as is commonly supposed), but it opened the way for the general application of steam power.

Watt became interested in improving the engine when he discovered, while repairing a model at the University of Glasgow, that its method of operation was extremely inefficient.

Power for each stroke was developed by first filling the cylinder with steam and then cooling it with a jet of water; this cooling action condensed the steam and formed a vacuum behind the piston, which was then forced to move by the pressure of the atmosphere.

Thus with every stroke, the cylinder was alternately heated and cooled, and calculation showed Watt that this process wasted three fourths of the heat supplied to the engine. Therefore if he could prevent this loss of heat, he could reduce the engine's fuel consumption by more than fifty per cent, an accomplishment that was obviously worth while.

He worked over this problem for two years but could find no solution to it. Then, "on a fine Sabbath afternoon," he took a walk; and, according to Usher,[5] this is his account of what happened.

> I had entered the green and had passed the old washing house. I was thinking of the engine at the time. I had gone as far as the herd's house when the idea came into my mind that as steam was an elastic body it would rush into a vacuum, and if a connection were made between the cylinder and an exhausting vessel it would rush into it and might then be condensed without cooling the cylinder. . . . I had not walked further than the Golf house when the whole thing was arranged in my mind.

The essential points in this experience, from the standpoint of creative thinking, are the following:

Watt had set up for himself a problem, which, after two years of work, his reason and imagination had failed to solve. One day, while indulging in a reverie during the enforced idleness of a Scottish sabbath, the solution of the problem came to him, unexpectedly, without effort, and without possibility of inspiration.

This experience is typical of illumination.

Other thinkers have left accounts of the action of illumination.

Hadamard[6] cites the following incident: "On being very abruptly awakened by an external noise, a (mathematical) solution long searched for appeared to me at once and without the slightest reflection on my part . . . . and in a quite different direction from any of those I had previously tried to follow."

Henri Poincaré[7] relates several similar experiences. In one case, an important conception came to him while he was boarding a bus; in another case, while he was idly walking by the seaside; in a third, when he was in military service. In all cases, the conceptions advanced incompleted work that had been laid aside temporarily and came with the same characteristics of brevity, suddenness, and immediate acceptability.

Another case that may be cited is that of the "benzene ring." The structure of the benzene molecule had baffled chemists for years. They found that it did not consist of a chain of carbon atoms, which was the only structure for this class of compounds they knew about, but no one could suggest an alternative arrangement that was satisfactory. Friedrich Kekulé worked on this problem without success until one day, when he sat daydreaming before his fireplace, the thought came to him that a closed ring of six carbon atoms would meet the conditions. This conception has proved to be one of the most valuable contributions to organic chemistry.

THE ACTION OF ILLUMINATION

These accounts stress the fact that illumination supplies desired ideas after the thinker's other resources have failed; but they may suggest that this mental process acts only on rare occasions and with certain people. If so, they give the wrong impression, for illumination is a normal factor in creative thinking.

Two examples, illustrating extreme cases, should help to show how it acts under ordinary circumstances.

In the first case, one who is working on a creative project by means of deliberate thinking runs along smoothly until he strikes a problem that halts his progress. He is well aware that the difficulty is a trivial one, but to his annoyance, hard thinking fails to overcome it.

After a few minutes of earnest thought, he relaxes his mental tension momentarily by stopping work and letting his attention dwell on something else. Then, "out of a clear sky," the desired ideas come to him, and he is able to go on with his work.

This manifestation of illumination is not particularly impressive, but it is identical in principle with that which occurs with striking results in the following case.

In this case, the thinker encounters a problem of great difficulty; but, as he has no way of knowing this in advance, he proceeds as usual, expecting to clear up the matter without much trouble. This, however, he fails to do. The problem resists all of his initial efforts to solve it, and, before long, he discovers that he has run into a serious obstacle.

[7] "Mathematical Creation (1908)," by Henri Poincaré, translated by George Bruce Halsted, The Foundations of Science, Science Press, 1913.

This is a critical point in his work. If he were like most people, he would stop here, giving up the problem as hopeless. But, being a creative thinker, he refuses to accept defeat, so he works on.

But no amount of deliberate thinking gets him anywhere. He develops and applies every promising method of solving his problem he can imagine, but all prove failures.

After struggling for hours, he runs out of ideas. Further thinking is useless, but his intense interest in the matter prevents him from stopping. Yet all he can do is to mill old ideas around in his mind to no purpose. Finally, frustrated and utterly disgusted with himself, he throws the work aside and spends the rest of his day in misery.

Next morning he wakes oppressed. His problem is still on his mind and he thinks about it gloomily. But as the fog of sleep clears from his brain, the tenor of his thoughts changes.

If, now, nothing distracts his attention, he soon finds that exactly those ideas he strove so hard to grasp the day before are now flowing through his mind as smoothly and easily as a stream flows through a level meadow. This is illumination.

Evoking Illumination

Even the thinker who is familiar with experiences like the foregoing is rarely able to account for them. They seem to happen erratically and without cause or reason.

Yet there is nothing mysterious about the action of illumination. Like electricity, it is a force that obeys certain laws, and, if these laws are understood, it can be utilized at will. Its apparent vagaries are due to deficiencies in the thinker's technique, and not to any uncertainty about its action.

It is not directly controllable like certain other mental processes, but it will be evoked whenever all of the following conditions are fulfilled.

1 *One must have a difficult problem to solve.* From the practical standpoint of the thinker, illumination is a problem-solving process. It is not incited by easy-going thinking, but it prepares for action whenever the mind struggles with some obstacle.

2 *One must think deliberately and intensely about the problem.* The principle underlying the evoking of illumination has been well stated by Torrey:[8] "When the mind is held unwaveringly and at concentrated attention upon the facts of a problem, some inner faculty of judgment and understanding pierces to their inner meaning and significance."

To fulfill this requirement the problem must be studied thoroughly by means of deliberate thinking. It must be viewed from every angle, and all of the essential factors involved must be carefully considered. Indolent or superficial thinking will produce no results; the price of illumination is hard preliminary work.

3 *The deliberate thinking must fail to solve the problem.* Obviously, if, as often happens, the thinker succeeds in solving the problem during the course of his deliberate thinking, no further assistance is required. Hence to bring illumination into action, all of the thinker's consciously directed efforts must fail.

Such a failure is always exasperating to the thinker, but it happens to everyone who deals with difficult problems. Far from putting a stop to further progress, it stimulates the mind to set other machinery into operation.

4 *Interest in the problem must be maintained.* Illumination, like the imagination, deals only with matters of paramount interest to the thinker.

As a rule, it can be relied upon to follow adequate preparatory thinking, because the thinker is likely to remain intensely interested in his problem as long as it baffles him. But if he does become more interested in something else before illumination occurs, his problem will remain unsolved, for illumination will fail him.

The remedy for this situation is to re-establish one's interest in the problem by continuing to think deliberately about it. This is never easy when a strong opposing interest has to be overcome; but, when the problem is once more the thinker's chief concern, illumination will act upon it.

Occasionally, when the mind is clear of obstructing interests, illumination will unexpectedly deal with problems that have been worked over but laid aside for days or weeks. Such manifestations are so dramatic that they are apt to be remembered and referred to in the literature, but they are too rare to be relied upon by thinkers.

5 *The mind must be relaxed.* Illumination is inhibited by deliberate thinking and cannot occur unless it has opportunities to use the mental machinery without interference.

These opportunities arise when the mind is relaxed and is concerned with nothing of importance. Conditions are apt to be especially favorable at the following times, for illumination comes most frequently on these occasions:

- When one stops active thinking during work and allows the thoughts to wander
- Just after work is put away for the day and dismissed from the mind
- On awakening from a night's sleep
- During reveries and daydreams.

6 *The mind must be unwearied.* Not only must the mind be relaxed but it must also be unfatigued to receive illumination.

As long as the thinker retains his mental vigor, illumination may come to him at any time during the working day; but it will not come when he is exhausted by a prolonged and futile struggle with a problem.

In fiction, thinkers often toil over problems until the small hours of the morning and are then rewarded with the all-important idea; but, in real life, this rarely happens. Normally, the tired mind must be refreshed by sleep before it is ready for illumination.

Utilizing Illumination

In practice, no attempt need be made to evoke minor manifestations of illumination beyond stopping work occasionally to give them a chance to occur if they will; but for major purposes this mental process is utilized, with a minimum of effort, by the following methodical procedure, which should be compared with the haphazard course of action described in a previous section.

The thinker proceeds with his work by means of deliberate thinking as usual, until stopped by a problem. If possible, he solves it with the mental powers at his command; but, if he is unsuccessful, he prepares to make use of illumination.

His first step is to continue his study of the problem until he is satisfied that he has carefully considered every detail. Then he sets the job aside and occupies himself with other matters.

For the rest of the day, his chief care is to safeguard his interest in the problem by avoiding activities that might prove too engrossing and, especially, any form of creative work. An occasional thought to his problem helps him to keep it in mind without starting up useless thinking about it. Illumination may act at any time during this period, but he does not expect it until next morning.

In the morning, he refrains from thinking about anything of importance between awakening and breakfasting and then gives

[8] "General Botany for Colleges," by Ray E. Torrey, D. Appleton-Century Company Inc., New York, N. Y., 1932.

himself an opportunity to meditate for a half an hour or so without danger of interruption.

Now he lets his thoughts dwell upon his problem and, if illumination takes place, ideas that he wants crowd into his mind and he finds himself master of the difficulties that baffled him yesterday.

If this does not happen—if he gets no new light on his problem or persists in thinking about other matters—it means that either his deliberate thinking of the day before was not sufficiently intense and comprehensive or his interest has been diverted. In either case, he must repeat his routine, with more arduous thinking, until results are secured.

After illumination, the thinker plunges into his work with enthusiasm and continues with unabated energy until his stock of new ideas is exhausted. Then, having disposed of this obstacle, he goes ahead with deliberate thinking until he strikes another.

Imperfect illumination. As a rule, illumination can be relied upon to deal adequately with problems that a thinker will set up for himself and will toil over, because he will take such action only with respect to difficulties that he feels capable of handling. But sometimes illumination supplies solutions that turn out to be unsatisfactory.

Usually, in cases of this kind, some vital factor was overlooked in the preliminary thinking. The problem, as set up, was correctly solved by illumination, but, as it was based on insufficient data, the answer obtained did not fit the real problem.

The remedy is to repeat the thinking, taking care to include all essential elements.

It is, however, not always easy to grasp all of the essential elements of a problem. Long study and research may be required before this can be done. In the meantime, the thinker works with incomplete data and faulty hypotheses and is constantly getting ideas that at first sight, seem right but, when tested, prove wrong. Many a problem has taken years of this kind of work before it was solved.

Of course, a thinker may try to solve a really unsolvable problem, but in this case illumination will help him to gain a true view of the situation and may suggest ways of attaining the desired end by other means.

V—EFFICIENT CREATIVE THINKING

As has been said, efficiency in creative thinking consists in carrying on work to a successful conclusion with a minimum expenditure of time, mental effort, and emotional distress. Several ways in which a thinker can increase his efficiency have been discussed in the foregoing sections, but, in view of their practical importance, a review of them is desirable.

Much time may be wasted by a thinker who does not understand the importance of getting or keeping himself in the working mood when the necessity arises.

To be able to think about a project creatively, he must have an intense interest in it, because, otherwise, he cannot command the services of either his imagination or illumination. Hence he will neglect work in which he has not acquired an interest or in which he has lost interest, and will direct his attention to other matters.

Of course, when his work is intrinsically interesting to him, there is no trouble from this cause; but ideal conditions do not always exist. To keep on working with a fair degree of regularity and without prolonged periods of creative inactivity, he must often force himself into the working mood, which centers his interest in his work, and he must prevent this interest from being superseded by others.

A great deal of mental labor can be saved by relying on illumination, rather than on prolonged deliberate thinking, in solving difficult problems. This can be done by the simple expedient of taking two days to solve such problems instead of trying to clear them up in a single day, thereby giving illumination an opportunity to deal with the matter.

In following this practice, the thinker works on a problem long enough to make sure that its solution is, for the moment, beyond him, and then drops it. Next day, after illumination has rendered its assistance, he works the solution out.

Experience will show that this "two-day" method of handling problems is easier, more satisfactory, and in the long run, less time-consuming than the attempt to dispose of them by continuous deliberate thinking; but it requires skill in the technique of utilizing illumination. In particular, two conditions must always be fulfilled.

In the first place, adequate thought must be given to the problem before it is dropped, or there will be no reaction. It is impossible to say how much thought is "adequate;" but in time, one gets to know fairly well when he has done a sufficient amount of work.

Secondly, proper preparations must be made to receive illumination in the morning. It will not come to one who immediately plunges into the affairs of the day on arising; it must have a chance to function in a relaxed and undisturbed mind.

Ways of providing this chance include: Taking a walk soon after breakfast, barricading oneself in one's study, and utilizing a long commuting trip to the office for meditation. A good and generally applicable plan is to rise and breakfast well ahead of the rest of the family so as to have an hour or so for quiet thinking.

During the course of his work a creative thinker may pass through a variety of mental states, such as indifference to a project in the beginning; a rather sudden acquirement of interest in it; complete absorption as he proceeds to work on it; annoyance when stopped by a problem; weariness, if he works too long on it; exasperation if it finally defeats him; delight when illumination shows him the solution; and intense creative activity as he develops his new ideas.

Without restraint, these mental states will lead to a series of emotional disturbances which may be severe, as exemplified in the "temperamental" artist whose moods vary from one extreme to another as his work goes badly or well. Such disturbances interfere with orderly, efficient thinking, and should be minimized as far as possible.

An understanding of the processes of creative thinking is helpful in this respect. One who knows what feelings will be aroused at each stage of his work can inure himself to them. Instead of being swayed by each passing emotion, he can carry on his work through its various mutations without losing his poise.

Inspiration brings new combinations of ideas, sometimes of the greatest value, without effort and stimulates the mind to a high degree of creative activity so that inspired thinking is easy thinking.

Though always accidental and uncontrollable, inspiration can be utilized much like the other creative processes by thinkers in a few lines of work. Thus landscape painters can search for it with success almost at will in their surroundings; writers can often find it by seeking new experiences; scientists, alert to any peculiarity in the phenomena under their observation, keep themselves in constant readiness to receive it.

But most creative thinkers cannot afford to depend upon it for any assistance in their work, because the chances that it will give them any helpful ideas are exceedingly small. They must rely only on their controllable mental processes for every step they take in creative thinking.

WILLIS RODNEY WHITNEY[1]

An Appreciation Based on Broderick's Recent Biography

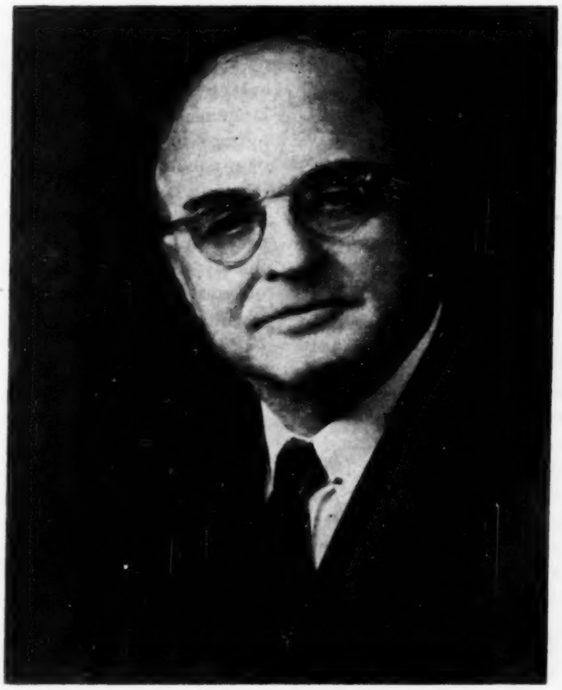
By DUGALD C. JACKSON

HONORARY MEMBER, A.S.M.E.

In Broderick's recent biography of Willis Rodney Whitney, pioneer director of the Research Laboratory of the General Electric Company, Karl T. Compton, who wrote the foreword, says:

"Few scientists have so impressed their ideals upon their contemporaries and followers as has Willis R. Whitney. He has largely set the pattern and philosophy of the modern industrial research laboratories, one of the unique achievements of this century. . . ."

"I am one of the many scientists to whom Dr. Whitney's intellectual stimulation, complete honesty and humility, abiding faith in the scientific method, and unbounded interest in young men have been a continued inspiration. I am therefore glad that many others may come to know him through this biography."



WILLIS RODNEY WHITNEY

Dr. Compton might well have added that Whitney's wisdom and sweetness of character have also endeared him personally to all those numerous men, women, and children who have become acquainted with him; and that this is in addition to his great achievements in inspiration in the field of research.

EARLY INTEREST IN RESEARCH

Willis R. Whitney was born in Jamestown, N. Y., on Aug. 22, 1868. His father was a manufacturer of furniture and seems to have had much sympathy with the youthful enthusiasm of his son Willis for scientific research. Willis' mother was apparently equally sympathetic. The parents early in his life presented him with a microscope and a microtome of his own with which he could work at his convenience. In those days the ownership of such refined instruments was very unusual for a boy, but young Whitney seems to have made them a center of interest for himself and other youths. In his own statement, it is shown that his mother impressed upon him during his youthful years that integrity topped the list of qualities that a boy ought to value. Moreover, his mother believed that every boy ought to learn some trade, and his father allowed him to work in the furniture shop for several summers during his school period, helping to make chairs. The father also tried hard to teach Willis the value of the dollar, and Whitney is still doubtful whether he ever learned it, although he has not been lacking for sufficient money throughout his life. He also seems to have had a grandmother who took much interest in the manner of the boy's upbringing. We see in these things the influence of parents and grandparents, and particularly mothers and grandmothers, which has been characteristic in the youth of many of our great inventors and engineers of great initiative. Whitney seems to have been a leader in a group of active-minded youths in his home community.

After his home schooling, Whitney entered Massachusetts Institute of Technology and graduated in the chemistry course in 1890, and there followed study in Europe under such masters of the foundations of chemistry as Ostwald in Leipzig and Friedel in Paris. This brought him to a post in the teaching staff of Massachusetts Institute of Technology in which he rose to an associate professorship; but in 1900 he went off to Schenectady, N. Y. (at first dividing his time between the General Electric Company and the Massachusetts Institute of Technology), to serve as the nucleus of a research laboratory which was broadly conceived under the wise guidance of General Electric Company's then chief engineer, Edwin W. Rice, who had the active financial support of President Charles A. Coffin who was a great industrial organizer. There Whitney achieved that great influence on the serviceability for the nation of scientific research for which he is notable. He became president of the American Chemical Society in 1910 and of the American Electrochemical Society in 1911. While still holding the M.I.T. professorship, he acquired a favorable reputation through his initiative and originality in research and improvements.

WHITNEY'S PHILOSOPHY REVEALED

Mr. Broderick, in his small book on Whitney, quotes a good deal from conversations with Whitney, whose philosophy of the serviceability of science and whose philosophy of life are set forth in various quotations in an interesting manner. For instance, says Whitney:

"A something from the sun that we call light, a something from space that we call air, and a something from the earth that we call solutions—these things make green things grow. This is still only half-understood chemistry. Cows eat the

[1] "Willis Rodney Whitney: Pioneer of Industrial Research," by John T. Broderick, Fort Orange Press, Inc., Albany, N. Y., 1945. Cloth, $5^{5}/_{8} \times 8$ in., 324 pp., 7 illus.

grass and produce milk, and the dairymaid makes butter and cheese, but these processes are also only partly understood chemistry. *We* eat such foods and unwittingly produce bones, tissues, and brains, and this is also only partly understood chemistry. Gradually the kind of chemist who makes dyes so permanent that even chlorine cannot bleach them, and has learned how to make ammonia, nitrates, alcohols, ethers, and almost anything from lime, coal, water, air, and electric power, will teach us more about the chemistry of life and better living."

And again: "I cannot explain better than to say that life itself is a process of chemistry, and thought and mind are parts of life. Physical and spiritual processes are reactions which obey chemical laws. . . . . .There is plenty of enjoyment in every field of chemistry, but the most interesting is man himself, first his simpler reactions, say, his reflexes, and then his more complex processes, say, his reflections."

"Scientists don't pretend to stand as racial representatives," he says in another passage, "but as simple appreciators of the infinite creation in which is to be found a boon for all humanity. In that area anyone so inclined is privileged to work and participate in uncovering new properties, processes, and mental satisfactions—all valuable assets."

"It would be foolish to try to explain fully what made up my interest in solutions and took me to Germany and to Ostwald's laboratory," he has confessed. "Probably it was just unending interest. I thought research was the finest of sports. I enjoyed it as a miser enjoys his wealth. It still seems the greatest game in the world. In most games, with a round or series played, and with the records or cards about to be reshuffled, the start of a new round or series must be made from scratch, while science always has a bigger and a better inventory with which to restart. My love of pure research may be a kind of selfishness. I may not understand it, but it has remained with me longer than most other folks live."

ORGANIZES G. E. RESEARCH LABORATORY

When he went to Schenectady Whitney had the advice of Elihu Thomson, one of our great electrical engineers and scientists, whose heart was in the development of the General Electric Company but who also had an active interest in M.I.T. Whitney possessed misgivings whether he would be free to carry on research in accordance with his ideals when he went to Schenectady but these were soon dissipated by the friendly attitude of E. W. Rice, the great Steinmetz, and others, which convinced him that he need fear no restraint through commercial expediency or oppressive urge from manufacturing exigencies, but that he could freely select his own problems and pursue them as far as he wished into the field of pure science. By 1904 he moved his family to Schenectady for good, although for a long time he remained a nonresident member of the faculty of M.I.T. and ultimately became a life member of the Corporation of the Institute.

The growth of the research staff at Schenectady was rapid, and, as Broderick puts it, the demands upon Whitney's time as director severely restricted his individual research activities, although he always maintained a workroom next to his office. "The Research Laboratory was losing a great experimenter but was gaining a yet more valuable asset, a great research director," says Broderick. As Dr. Arthur D. Little one time said, "Whitney can talk to a man for three minutes and inject into him enough enthusiasm to last three months." All of the activities of the laboratory were constantly under the influence of his resourcefulness and knowledge and his courage and optimism were always a help when obstacles arose and hopes were temporarily dashed. Whitney considered that obstacles were a natural part of the course of high research and were to be overcome with enthusiasm. "The self-satisfied," said he, "prefer to have their obstacles removed, but apparently the overcoming of them is an elevating process."

He also insisted upon a liberal policy in regard to publication of the results in pure science of the laboratory, and also of serviceable applications of discoveries after time had been allowed for the due application for patents in the Patent Office, in order that the men under his direction should promptly contribute to the welfare of the world as well as to the General Electric Company and that his men should receive due recognition of other men of science throughout the world. Whitney has said, as quoted by Mr. Broderick, "In spite of our crippling of ourselves or our enemies, science has spread its truths willy-nilly. Perhaps they deserve no special credit, but scientists everywhere and at all times try to publish promptly, and in all languages, all the new truth they can discover, regardless of nationality, color, creed, or previous conditions of servitude of anyone concerned. Not infrequently they even pay the cost of printing it."

Whitney had much distress from the numerous suggestions of important problems, the solutions of which would meet long-understood needs if they could be made, as the suggestions ordinarily failed to recognize that those solutions could only come from fundamental discoveries in science. In an address to young scientists in 1936 he said, "It is almost a question whether you ought not to be warned against too great effort expended on long-wanted or prescribed needs. Engineers in any field can easily misdirect a young research man's efforts against impenetrable walls. . . . If a want has been felt long and persistently, it is possible that sufficient heads have already been broken over it. It is distinctly more fun, and perhaps more profitable, to utilize things in your own field that you didn't suspect would be needed, even products you didn't suppose could exist."

RETIRES FROM ADMINISTRATIVE DUTIES

Thus Whitney established his notable reputation and influence. In 1928 he was appointed vice-president of the General Electric Company in charge of research, and in 1932 he relinquished the directorship of the laboratory to Dr. William D. Coolidge, who had long been his associate. He thus was freed to return to his earliest and dearest love, experiment. Since that time he has been free again to carry out his own individual ideas, although he maintains close relations with the Laboratory. When it was announced that he had "retired," an editorial was published in the *New York Sun* with the heading, "Dr. Whitney Retires, Pooh!" It ran in this manner:

"Dr Whitney in seclusion, Dr. Whitney in retreat, Dr Whitney withdrawn from circulation—these are unthinkable. The Whitney intellect has served knowledge too long to be suspended in its operations by a mere rearrangement of opportunities. The Whitney curiosity has so persistently projected into the abyss of men's ignorance that no shifting of titles can restrain it from future excursions into that fascinating unplumbed gulf."

The editorial paragraph referred to ends with, "And, ultimately, Dr. Whitney possesses a sense of humor and a quality of wit which veto the notion that a useful man should or can retire."

The author Broderick compares Whitney to Franklin. Says Broderick, "Whitney's activities, to be sure, unlike those of Franklin, have not extended to problems of statecraft, but in vision, versatility, and love of experiment he bears a striking resemblance to the inventor of the lightning rod."

Whitney has always been interested in young folks, and his relief from the constant attention needed on the part of the director of the Research Laboratory of the General Electric Com-

pany has enabled him to continue carrying out that interest. It has apparently been great fun for Whitney as well as fun for his young guests whom he has entertained individually and in parties at his house. At one time he held parties at his home on Saturday afternoons for the children of the Laboratory workers. His influence therefore will live through at least another generation and probably will always remain a mark in the development of scientific research in this country.

WISDOM AND HUMOR SHOWN

In his many conferences with Dr. Whitney, Broderick found that Whitney would not undertake to be a prophet, but nevertheless the author gathered together many Whitneyisms which show Whitney's wisdom and humor. Said Whitney to the author, "I'm loath to make specific predictions, partly because I don't believe I could qualify as a reliable forecaster. One reason for that is that research is quite as likely to lead to the unexpected as to the expected." (Here Whitney might have repeated the old saying that the unexpected is always happening.) "Often while we are endeavoring to corral something of which we may have a fairly clear mental picture, we find something else of more consequence, and the unexpected thus becomes the important discovery or invention, to the discomfiture of the prophets, whose clients have naturally put their money on the expected."

Again, Whitney quotes Francis Bacon, who wrote, "Axioms determined in argument can never assist in the discovery of new effects, for the subtlety of Nature is vastly superior to that of argument."

"How can I prophesy?" says Whitney in another passage. "No prophet could predict millions of dollars of business to a lamp company for making bulbs to produce invisible light. But it came! X-ray tubes were not contiguities of incandescent lamps, but they lit up our bones. No prophet would advocate fevers to cure the sick, nor predict that the building of equipment for this 'unnatural' purpose would develop into an active business. All one can predict is that if we are sufficiently inquisitive we may find what we didn't anticipate, and some of the things found will be wanted."

Elsewhere he says,". . .all of us, particularly the youngest, are in rare world positions. Things on every side are changing, and if we aren't also conformably and constructively changing, our lamp may be already out."

And again, "When I stop dreaming and consider the past which I have seen, it becomes continually clearer that we can never reach a limit of discovery while we inquisitively work. Each new item of our electrical past has opened still more fertile areas in the unknown. Our industry began in a vacuum lamp, it spread to power generation, and now reaches into countless lines (and provides many new lines) of human interest. We need never reach a time when the future of electricity can be bounded even in dreams, if we will only keep sufficiently awake."

Again, says Whitney, according to Broderick, "But we must wait for those who will go to work and apply the new knowledge in practical ways before we realize what each new 'rabbit,' trapped by discovery, may be worth.

"And while that is going on most of us must also wait while the philologists, the wordmakers, or idiomatists, get their work started coining words which we have to use to tell one another what it is all about. Such words as we have were coined to fit what we know. Other words will be required to name the things yet to be known."

He deplores mental complacency: "That's because complacency or mental fixity is so common, because pioneers are rare and pioneering is fraught with hazards for anyone with a flair for it."

On the subject of war, says Whitney, "If we spent our great efforts, now and at other times used in mutual destruction, trying to be of practical help to our world fellows, no one could place a ceiling on our possibilities. It all seems so clear to me now that I am sure it will dawn upon many others in time. I have merely been in a favorable position to see the possibilities in co-operative effort in science or the discovery and use of new truth."

CONCERN FOR CASUALS OF THE DEPRESSION

During the period while Whitney was officially director of the General Electric Company's Research Laboratory, the depression of the '30's came on the nation, to the great distress of Whitney, because of the discomfort it imposed on many of his associates. Says Broderick, "The scaling down of research-laboratory disbursements amounted in the end to more than 60 per cent, although, because of a resort to part-time employment, the reduction of the research force itself was not as great as that." Also, for Whitney, "with his sanguine temperament, his eagerness 'to go places and see things,' his love of pure research and desire for its continuance, the crisis was little short of a tragedy. He felt as a father with half a dozen sons would feel if three or four of them were suddenly taken from him by some illy understood disease. The laboratory folk were in no sense time-servers. Their hearts were in the work they were doing."

The quest for new knowledge that would probably or possibly lead to the bringing forth of new and useful things was truly a labor of love for them all. Turning many of the workers adrift was literally breaking up a happy family. "And what was doubly distressing for their chief," says Broderick, "was the consciousness that, highly specialized as for the most part they were, they could not hope readily to find employment elsewhere." Whitney's background had aroused the feeling that "research has become engineering support," and "there is no ceiling to new knowledge and so no apparent limit to human advance." Pessimists, defeatists, were not helpful to Whitney as employees of the Research Laboratory. His was a world of optimism. Says he," . . . speculation in science is good medicine and truth will be advanced by our trying to distinguish instead of extinguish it." And "Even remote things may be intimately related when one hits the trail for truth. Nature seems to be a co-operating and complex combination."

MANY HONORS BESTOWED ON WHITNEY

These great mental attributes came to be recognized in engineering so that Whitney in 1943 was made the recipient of the John Fritz Medal, the leading recognition at the joint formal disposal of the great societies of American engineers, and he received the fine tribute that the medal was conferred "for distinguished research, both as an individual investigator and as an outstanding and inspiring administrator of pioneering enterprise, co-ordinating pure science with the service of society through industry." Speaking of the present shortcomings of man's mentality, Whitney has said, "To acquire knowledge of such truths is the aim of true research no matter how, or for what ends, the knowledge is applied. That there seemingly are some harmful applications, now and always, is a pity, but it only means that man as yet is but partially developed, that he needs more and more increase of wisdom, which, I devoutly believe, is bound to come as the results of diligent research draw him nearer and nearer to infinite truth."

Whitney has received five honorary doctor's degrees from American universities, and he has received principal medals of many scientific societies—the Willard Gibbs Medal of the American Chemical Society "in recognition and encouragement

of eminent research in theoretical and applied chemistry;" the Chandler Medal of Columbia University "in recognition of wonderful and successful labors in the application of physics and chemistry to the industries of the country;" the Perkins Medal of the American Section of the Society of Chemical Industry "for original and valuable work in applied chemistry;" the medal of the National Institute of Social Science "for distinguished social service, for promoting and leading in electrical and chemical research, for the application of science to the welfare of man, for far-reaching contributions to human progress;" the Franklin Medal of The Franklin Institute "in recognition of signal success as organizer and director of the greatly productive research laboratory of the General Electric Company, a success due in large part to his appreciation of the potential value of pure research in invention and industry, to his judgment of men and to his generosity in dealing with them;" the Edison Medal of the American Institute of Electrical Engineers "for contributions to electrical science, pioneer inventions, and inspiring leadership in research;" the Marcellus Hartley Public Service Medal of the National Academy of Sciences "for pioneering work in making science available to industry by his creation and development of our research." The John Fritz Medal has already been referred to. Whitney has also been made Chevalier of the Legion of Honor for his pioneer work.

AN AUTOBIOGRAPHY NEEDED

Such, and more, are the touches of the greatness of mind, the wisdom, and the friendliness and enthusiasm of Whitney which we get from the Broderick book; and every touch will be confirmed by those who have personally known him. The book also contains a number of illustrations in the way of photographs of men. One is of Dr. Whitney, whose face shows his fine human qualities and his friendly characteristics, another is of Whitney with a boy and a turtle, another of Whitney and his dog, and another showing Whitney studying goldenrod gall in which he became interested in connection with his biological studies. An excellent picture of Elihu Thomson, one of Steinmetz, and a picture of Whitney, Coolidge, and Langmuir unveiling a plaque in honor of Elihu Thomson are likewise found in the book.

Mr. Broderick has brought together many incidents of Whitney's life which indicate the background of his accomplishments, and the book may be read with interest regarding the affairs of Whitney and several of his leading associates; but it seems to the reviewer that we have not yet been provided with the book which shows more fully the human sympathies and kindliness of character which have led to Whitney's great influence on our nation in impressing upon the minds of the people the great serviceability of adequately supported scientific research within the industries and outside of them. Whitney's qualities of sympathetic appreciation and kindliness of spirit led him as director of the developing and developed Research Laboratory of the General Electric Company to yield his own delight in carrying on his individual problems of research—to yield that joy to associates, while he recognized that, with competent men associated with him, more problems could be dealt with than he could deal with by himself and more would be suggested than he would suggest himself, while he was satisfied to accept vicariously his joys in the work. Perhaps we cannot receive such a return except through a serious autobiography written by Whitney himself, by means of which we can more completely learn the driving intellectual forces impelling great leadership.

WHEN CANDID CAMERAMAN BOB LEAVITT OF THE *American Magazine* VISITED DR. WHITNEY AT HIS LARGE FARM SOUTH OF SCHENECTADY, HE CAUGHT HIM TALKING TURTLE WITH PAUL, A FIVE-YEAR OLD BOY FROM A NEIGHBORING FARM

JOB EVALUATION *and* MERIT RATING

The Problems Encountered by Management and Labor in Their Installation

By ASA S. KNOWLES

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IN THE handling of wage and salary problems today the spotlight is focused on general increases in wages and salaries. In the next few years, however, internal wage structures will receive more attention. The emphasis will shift from wage increases to problems of internal adjustment in order to minimize pay inequalities.

More than ever before job evaluation and merit rating are recognized as the best means for correcting internal maladjustments in pay rates. Consequently there is currently a renewed interest in the adoption of job evaluation and merit rating as tools of wage and salary administration. Because of this there is need to re-emphasize some basic concepts concerning job evaluation and merit rating and the problems encountered in their installation; these are:

1 What is job evaluation?

2 What can be expected of it by management and labor?

3 What considerations require attention at the outset of any program: policies, special problems of job analysis, weighting of job measures, etc.?

4 How is merit rating used for wage and salary determination?

5 How should it be used jointly with job evaluation?

Job Evaluation Defined.

Job evaluation involves three steps, these are: (1) Job analysis to uncover facts about jobs to define their requirements, (2) job rating to record judgment concerning the relative worth of jobs as revealed by differences in job requirements; (3) the pricing of jobs or setting of base rates using job ratings and certain other information as a guide.

Every job situation consists of the job itself and the job holder. Job evaluation and merit rating should therefore go hand in hand as tools of wage and salary administration. Job evaluation should guide in the establishment of base rates, and merit rating in determining the amount of pay to be added to the job base rates to compensate for job performance. While merit rating is a valuable guide, in most instances job evaluation is used apart from merit rating. Job ratings plotted against present pay rates on a scatter diagram provide a valuable guide for deciding which jobs are correctly paid, which are overpaid, and which are underpaid.

Job Evaluation vs. Job Classification.

A thoroughgoing plan of job evaluation gives no consideration to present pay rates as part of the process for establishing the relative differences in the requirements of jobs. The honest evaluation of a job demands that its relative position in the pay scale be based solely on an impartial, unbiased, factual analysis of its requirements. To consider present pay rates in advance or as part of a job-rating procedure serves only to perpetuate errors in pay rates which job evaluation is designed to correct.

Any plan of job rating which uses present pay rates as one of the measures for setting a rating scale or for deciding the relative importance of jobs is more properly designated as a plan of *job classification.* This is a technical distinction and is not intended to deride the value in use of any job-classification system. It serves to emphasize that the weighted point methods of rating jobs are the only ones which achieve the original objective of job evaluation. The weighted point method defines jobs and then rates them by assigning numerical scores which reflect differences in job requirements. Only when this job rating is completed is any consideration given to existing pay rates as one of the considerations of pricing jobs or setting base rates.

What Management and Labor May Expect of Job Evaluation.

The published literature of job evaluation stresses its advantages. It will suffice here to list these: Job evaluation results in fair rates of pay within a given organization—prejudice and emotional discussions are minimized; it contributes materially to improved organization—job analysis uncovers the realistic lines of responsibility and authority; administrative efficiency is improved by job evaluation—supervisors learn to know what they are supervising, and correspondingly, work assignments are made more effectively, assigning the right man to the right job; the collective-bargaining process is improved by the factual data about job requirements; finally, increased morale results when workers understand that both management and labor are trying to develop rates of pay which recognize that jobs vary in their requirements and should therefore be compensated accordingly.

While the advantages of job evaluation in use clearly outweigh any of its limitations, those who are planning to undertake job evaluation can profit most from its use if the limitations are understood in advance; these follow:[1]

1 *Job Evaluation Not a Mathematical Formula.* Job evaluation is not an exact tool and does not provide a formula. It may be termed properly as systematic considered judgment. Judgments concerning the worth of jobs are reached by use of job definitions which have a uniformity and inclusiveness which is entirely lacking in offhand opinion. Common measures which are sufficiently broad to define all jobs within their range replace guesswork in appraising what a job is worth.

2 *Job Evaluation a Guide Only in Setting Pay Rates.* The results of any job evaluation must be used primarily as a guide.

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., November 26–29, 1945, of The American Society of Mechanical Engineers.

[1] Based on Chapter 2 of forthcoming text on "Job Evaluation and Merit Rating," by Asa S. Knowles.

Seldom is it possible to develop a system of pay rates to correspond to the actual worth of jobs to an organization as revealed by job evaluation. Consideration must be given to factors such as community rates, union scales, and other factors.

3 *Greatest Usefulness to Settle Intraplant Inequalities.* While the new plant starting from scratch might use job evaluation to establish a pay scale, there are relatively few organizations which have this opportunity. The greatest use of job evaluation is to settle or iron out inequalities in pay rates which exist within a given organization.

4 *Job Evaluation a Long-Range Proposition.* The installation of job evaluation is a long-range task. Job evaluation reveals the theoretical and desirable pay for each job in relation to its requirements. It seldom results, however, in modified rates overnight. Intraplant inequalities must be corrected gradually. In fact, no organization should expect to have a complete correction of pay-rate inequalities in a time shorter than three to five years, or perhaps longer.

5 *Considerable Time and Cost Involved.* Both time and money are involved in installing job evaluation. The expense of hiring a consulting firm is a considerable one. Most installations require several months to make, and people within the organization itself must be assigned to work with consultants making the installation. The expense is not lessened by any great amount if an internal staff does the job. The salaries of those competent to do the work, together with their assistants will approximate the fees paid a consulting organization. In addition, supervisors must be trained in job evaluation. This takes time from their regular work. Moreover, workers must be interviewed on company time, and the time of plant officials is involved in passing upon and reviewing job ratings.

6 *Job Evaluation Without Merit Rating Limited in Usefulness.* Fundamentally, job evaluation discovers what jobs themselves are worth. Every job holder is paid not only for the job itself, but also for individual performance over and above minimum job requirements.

7 *Union Co-Operation Needed.* In an organization where wages and salaries are set through collective bargaining with union representatives, the time and cost spent in developing a job-evaluation program may be wasted unless the union is willing to accept the findings. Union co-operation is needed from the outset of the development of any program.

8 *Job-Evaluation Results Increase Total Pay Roll Temporarily.* The final results of job evaluation may indicate that more money should be paid for some jobs. It may be a sizable number. Sometimes one third of the ratings fall below minimum-wage standards for a community. Good policy dictates that these jobs be increased to the desired minimum. Seldom is it possible, however, to make immediately downward adjustments in the value of jobs which are overpaid. In the long run these downward adjustments can be made.

PRELIMINARY CONSIDERATIONS

Policies. There are important policy considerations which deserve attention—questions which employees will ask as follows:

1 What is job evaluation?
2 How are individual pay rates to be decided?
3 What use is to be made of the results?
4 What job measures are to be used in appraising jobs?

Answers to these questions must be known in advance and job analysts must be prepared to handle them by giving uniform answers or the competence of the staff doing the work may be questioned.

Some of the broader policy considerations are:

1 *Selection of the Staff.* Every organization must decide for itself whether the completion of job facts and rating of jobs is to be done by consultants or by members of a company's own staff. Regardless of which group does the work, full-time job analysts are necessary. These must be selected with considerable care. Moreover, sound policy dictates that job analysts confine themselves to the role of fact finders and avoid becoming involved in pay-rate adjustments.

2 *Range of Jobs.* While theoretically it is desirable to include all jobs at every level of an organization, it is seldom done. A decision must be made as to what jobs should be evaluated and which group of jobs is to be evaluated first. In general, jobs up to the rank of supervisor are included in programs affecting the shop, and where salaried jobs are involved, up to junior executives.

3 *Selling the Program.* If job evaluation is to be successful it must be wholeheartedly accepted and endorsed not only by top management and supervisors, but also by the rank-and-file workers. The best method of selling the program to all concerned is a primary policy consideration.

4 *Employee Participation.* Opinions concerning the extent to which employees should participate in job evaluation are not uniform. There are those who believe that employee participation brings about an appreciation of the difficulties concerning the establishing of pay rates. Others, however, find that when the employees become involved in job evaluation, they become too concerned with "what the other fellow gets."

5 *Union Participation.* Where union organizations are active, the co-operation of the unions is essential for the success of job evaluation. A representative of the union should be on the policy committee to help formulate job-evaluation policies. The union representative should be asked to help in checking definitions of jobs and ratings of jobs. There are some organizations, however, which believe that management should develop job evaluation first and then submit it to union representatives for collective bargaining. If the union must accept the final results, it seems only reasonable to have the union group participate from start to finish. Only in this way will union officials be in a position to tell their rank-and-file members that the program has been soundly organized and completed, making it worthy of acceptance.

Special Problems of Job Analysis.

Job ratings are no more reliable than the data on which they are based. The type of job questionnaire which is to be used to collect job facts deserves careful attention at the outset of any program. Questionnaires vary in length and detail, as well as the latitude permitted job analysts in interpreting job facts.

Job-facts questionnaires should force job analysts to be consistent in their use of terminology and in the questions asked about all jobs. It is not fair to ask questions about one job that are not asked about others. Moreover, facts about jobs should be collected in terms of the language to be used in job rating. Consistency in terminology can be forced by requiring all job analysts to use a glossary of definitions of the terms which appear in the job-analysis questionnaire and job-rating form. An example follows:

GLOSSARY OF DEFINITIONS

Alertness	Being vigilant; on the watch; ready for any occurrence.
Attention	The direction of the mental faculties to a specific object or thing.
Elemental	Rudimentary; of extreme simplicity.
Formal teaching	Giving of instruction to organized groups for advancement of learning.
Intricate	Highly complicated or involved; difficult to follow or understand.

Occasional Occurring at intervals but not at a fixed time or with specific regularity.

Routine Regularly followed course, prescribed; carried out day after day.

Uniformity in asking questions in collecting job facts is assured by having a questionnaire form which requires the job analyst to check answers, filling in explanatory details only, as shown in the following form:[2]

	Degree	Points
JUDGMENT		

1 What ability to make decisions is required and how are these decisions formulated?

	Independently	By group action	Affecting own work	Affecting others
Small amount to make elemental decisions				
Moderate amount to make routine decisions				
Medium amount to make interpretative decisions				
Considerable amount to make executive decisions				
High amount to make administrative decisions				

Explanation:

There follows a definition for the common job measure of "judgment." When these are checked against the questionnaire form it is clear that the job facts are directly related to the terminology used to define jobs and used to rate them.

Judgment. The ability to make decisions through comparisons, selection, and discrimination.

Degree	Max points
First Small amount of judgment required to make elemental decisions which affect own work only....	15
Second Moderate amount of judgment required to make routine decisions which expedite job performance for own work or that of a few others with advice of superior..	30
Third Medium amount of judgment required to make interpretative decisions which affect own work or that of others with or without advice of superior......	45
Fourth Considerable amount of judgment required to make executive decisions which affect primarily the work of others, usually without advice of superior..	60
Fifth High amount of judgment required to make administrative decisions which affect only the work of others. Decisions must be made carefully and rapidly without advice of others.........	75

Weighting of Common Job Measures. It is possible to use job measures and numerical weights assigned to them on a uniform basis in several different plants of one industry. It is not desirable always, however, to transfer a set of measures and the weights assigned to them from one industry to another. For example, the measures and corresponding weights which might apply in the glass industry as reflecting the importance attached to various job measures do not necessarily apply in the textile industry. It is important therefore in using any measures and weights which are already established to adjust these so that they reflect the true situation of a particular industry. In some instances it has been found desirable to change weights of measures as used in one plant of an industry to reflect truly differences in working conditions, hazards, and so on, which exist in a particular plant.

There follows a list of the common job measures which are common in the sense that they permit the definition of all jobs within their range. They are not necessarily common in the sense that all job requirements are part of each measure. The numerical weights attached are for purposes of illustration.

COMMON JOB MEASURES

Measures:	Weighted point values
SKILL:	
Mental:	
1 Education and experience	50
2 Judgment	75
3 Resourcefulness	50
4 Exactness	50
Manual:	
1 Dexterity	50
2 Versatility	75
Social	50
RESPONSIBILITY:	
Equipment, plant, and property	50
Financial expenditures	25
Methods, policies, and rules	50
Safety	75
Supervision	75
Training	25
EFFORT:	
Mental	75
Physical	75
WORKING CONDITIONS:	
Accidents and health hazards	50
Environment	100

Merit Rating for Wage and Salary Determination.

Merit rating as used in wage and salary administration is a guide for deciding what compensation should be paid a job holder to reward him properly for his job performance in relation to specific job requirements.

Joint Use of Merit Rating and Job Evaluation.

When job evaluation and merit rating are used jointly, it is important to recognize that the same measures used to define jobs should also be used to appraise performance. Some organizations have defined jobs with one set of measures and then overstressed personal attributes in a merit-rating form used to determine a pay differential to reward job performance. If social skill is recognized as being 10 per cent of a total job requirement, it should be given the same significance in a merit-rating form. The common job measures used to define a job with the exception of working conditions should be used to rate job performance. When the measure named "working conditions" has been eliminated, the remaining measures should be weighted in the same proportion as the weights assigned to the common job measures. For this purpose the job itself may be considered to be worth 70 per cent of the total pay, and the worker's performance 30 per cent.

[2] Reproduced from Job Specification and Rating Form prepared by the author for the exclusive use of Thompson and Lichtner Company, Consulting Management Engineers, Boston, Mass.

WAGE INCENTIVES

Their Sound Application in a Peacetime Economy

By J. K. LOUDEN

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WAGE incentives, while a controversial management tool by their nature, are an important factor in solving the problems of proper compensation in our peacetime economy.

As might be expected, the conclusion of the war and the rush to reconvert to peacetime production have made our national industrial picture somewhat confusing as we witness the effect of many conflicting interests as individual companies and groups within the country are struggling to regain their stride and square away for their role in our peacetime economy. We are struggling to free ourselves of the artificial conditions of producing for war, wherein the problem was all-out production for a single purpose and primarily one customer—the Government, with costs playing a secondary role—and to adjust our thinking and planning to meet the competitive situation we face today.

While we are returning to an economy wherein there is a great scarcity of goods, not only in consumer lines but also in most capital-goods lines, we are also returning to an economy that will be more highly competitive than the one we lived in before the war. It is true that the first great heavy demand for goods will mean that every manufacturer will find a ready outlet for his product. However, when that first critical phase is over we will begin to realize just how competitive the increased productive capacity of this country has made our industrial system.

There are few, if any, types of manufacturing enterprises or industries that have not had their production facilities increased during the war. There are few that have not increased their production know-how and improved their managerial techniques to the point where they can out-produce the normal needs of this country, as well as our export markets.

During the war we faced the situation wherein the "take-home" pay of hourly workers in particular was increased sharply due to longer hours and higher wage rates. This has brought about one of the most critical situations of the reconversion period wherein organized labor is demanding that this wartime take-home pay be maintained while hours are reduced to the prewar normal work week, claiming that the various companies whose employees they represent have proved by their wartime earnings that they can afford to pay these higher wages for shorter hours and less work. The fallacy of this argument is obvious and yet that does not alter the fact that the demand is present. Regardless of the equity of these demands, we must realize that we are going to pay at least as high hourly rates now as we did during the war, and ways and means will have to be found to protect in part the take-home pay of the workers. The situation is not made any simpler by some government officials stating that industry generally can afford to pay these higher wages for reduced hours and less work and still maintain prewar selling prices.

The obvious answer is that each plant must determine for itself what it can afford to do. This will vary widely depending on the margin of profit that exists for the product the company manufactures plus the percentage that labor represents of the total cost of manufacturing that product. In every instance though, it means that management must seek every way and means it can to reduce its costs in order to meet in part these demands for higher wages.

There can be no objection to the principle of increasing wage rates, because we all know that the only real ceiling that should exist on wages is our ability to earn them. If we accept this principle, then we must recognize that a sound wage-incentive system is one of the most equitable devices that will permit increasing take-home pay, while at the same time at least maintaining unit costs, and in most cases playing a part in reducing costs.

Before we discuss this problem more specifically I think we should define what we mean by wage incentives. There are many definitions, but I think that for our purpose we can state that the fundamental purpose of an incentive system is to offer a financial incentive to a worker, or group of workers, to produce work of an acceptable quality over and above a specified quantity. Obviously our problem, in so far as the use of wage incentives is concerned, rests primarily in the "specified quantity" and secondarily in the "specified quality."

REASONS FOR OPPOSITION TO WAGE INCENTIVES

The acceptance of wage incentives as a wage-payment device by both organized and unorganized labor varies all the way from a refusal on their part to permit their use to their wholehearted acceptance. That being the case, then we must analyze the reasons for the opposition. I believe we will find it falls into two general categories: one being the desire of labor leaders to control the rate of output for what they believe to be their benefit. It is not within the scope of this paper to discuss this particular phase of the opposition but we cannot let it pass without stating that regardless of whatever the motive may be on the part of the labor leaders for this attitude and policy, there is no question that if it is carried out to the point where it becomes a truly dominating factor in our national production picture, then we can only realize that as individual companies—and if it becomes widespread, as a nation—we are placing our feet on the downward path to a lower scale of living and the dimming of our lights as the leading industrial nation in the world.

Regardless of the social and economic problems we face and the confusing issues that may arise from them, we must keep before us the fact that the true wealth of a nation rests in its ability to produce. Therefore it is our responsibility as citizens and as members of management to do everything we can to prevent harming our great heritage. We must, within our own realm and in working together with labor, find ways and means of breaking down this restriction of production on the part of organized labor wherever it exists.

The second major area for opposition to the use of wage incentives by labor rests primarily on its unhappy experience with various wage-incentive plans and installations in the past. The basis for this opposition in large part rests in management's

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past actions and concepts of the use of this tool. Its solution rests in management's ability to face the issue squarely, realize what constitutes a sound basis for the use of incentives, and the degree of its determination to eliminate any misuses of incentives in its establishment, or if it is an initial installation, to make certain that it is being made on a sound and equitable basis.

If incentives are not in use in a plant, then the ready means to increase take-home pay from 20 to 30 per cent is at hand. However, where management turns to this device as a ready and easy solution to its wage problems before it truly understands their use and is ready to install them on a sound basis, then it is laying the pattern for resistance that is very difficult to overcome.

Exactly this situation occurred at the conclusion of World War I, and I am very much afraid that the hasty use of incentives during this last war has in many cases caused the same damage. Wage incentives are not a panacea and they in themselves are not the end we are seeking, but when properly used they are definitely a means to the end of increasing productivity, paying higher wages, and reducing costs.

TECHNOLOGICAL CHANGE

As we delve more deeply into the past practices that have brought about this admittedly justifiable opposition to incentives in many cases, we must broaden the scope of our discussion to include technological change generally, because I do not think that they can be logically separated since many of the basic reasons for opposition to one are the same that exist for the other. In our discussion of technological change and what constitutes a fair day's work in the establishment of wage incentives, let us take a look backward and review their history in the light of our problems today.

Wage incentives are as old as mankind. We find reference to their use in the Bible and throughout history. In some form they have been used for years in an attempt to reward workers to increase production. We find their growing use in industry in this country in the early 1900's and it was during this period that their installation by unskilled people, and their use by managements who did not understand what constituted a sound basis for their use, formed the foundation for the opposition we are discussing. Many of us can remember many of the practices and policies that existed during that period. We witnessed the overdemand for the services of trained qualified men that laid the profession of industrial engineering open to untrained opportunists and to efficiency experts with few if any qualifications and the evils such men and situations bring with them.

The past decade has seen substantial improvement in this work. Two factors have been responsible for bringing this about. One is the growing realization by management of what constitutes sound practice in this work, and the second is the demand of organized labor for fairer wage practices.

The evils that existed in the use of incentives, particularly during the period 1915–1930, and their effect in forming the opinion of workers on the use of incentives, are facts we must face and face realistically if we are going to overcome them. It is not sufficient to say that our policies are now equitable and should be accepted with full faith by our workers. We must be ready to prove our policies to our people in practice before we can expect them to be accepted in full faith. They in turn must be willing to give them a fair trial.

PAST PRACTICES

Let us look at some of our past practices and discuss them briefly. I have chosen eight evils which I think were the greater and more common ones.

1 *Failure to have supervision play a major role in the industrial-engineering program and the failure to train them in the fundamentals of industrial engineering.* To fail to recognize the fact that the foreman is the manager of his department seems inexcusable in the light of sound management thinking. To fail to recognize that if the foreman is not sold on a project or does not understand it, his men will realize it and be against it also. Nothing can wreck the morale of a department more than ignoring its supervision or forcing something unknown upon the foreman and his department.

The majority of our problems in labor relations that mushroom into serious situations could be stopped in the very beginning if our supervisor were fully and properly trained in the techniques of management and industrial engineering so that he could successfully meet the situation and solve it before it gets out of hand.

2 *Failure to enlist the co-operation of employees and to gain their full understanding and confidence.* This failure is as obviously unsound as failing to work with and for the foreman, and it demonstrates a lack of concept of what constitutes sound employee relations. It probably grew primarily out of the incompleteness of techniques, lack of personal competency, and general unsureness on the part of the people making the installation. They wrapped themselves in a shroud of mystery and with an airy, "This is something you couldn't understand," sowed the seeds of bitter resistance and opposition to this work.

Management cannot be proud of the relationship which has existed between wage incentives and good employee relations. It would pay us well to review this association carefully and frankly, and to profit by the mistakes we have made, and look to the future and build toward the sound relationship which can and must exist.

Full-scale collective bargaining has complicated this relationship, but that only intensifies the necessity for successfully solving it.

3 *Failure to recognize the caliber of men and the competency required to perform this work.* The performance of industrial-engineering functions by untrained or inadequately trained men is a fault that must be shared by both management and practicing engineers. The desire of management to get the job done at as low first cost as possible, plus its own lack of knowledge of what was involved, were major causes. The lack of truly competent engineers and the lack of college curricula designed specifically to train men for this work were other factors.

Fortunately, management generally has come to realize the importance of this function and is now more willing to set it up properly and to staff it with competent people. If any management is not willing to set up this industrial-engineering function properly and man it with competent people, then it is not in itself ready for such a program and should not have it.

4 *Failure to establish standard procedures and policies governing industrial engineering.* This includes not only the use and application of the techniques of industrial engineering but also the application of results obtained, such as a wage-incentive plan. The establishment of standard techniques in a detailed manner for all engineers in a company is still not a common practice. Yet if uniformity of results is to be obtained, it is essential. Written policies governing wage incentives were usually vague, if existing at all. These problems were frequently left to the whims of department heads and the head of the pay-roll department. The pattern followed was often one of inconsistency and its resultant confusion and discontent.

5 *Failure to realize that industrial engineering consists of more than taking time studies and installing a wage-incentive system.* If one evil had to be selected as the greatest it would be hard to deny the place to this mistaken concept. The old practice of

going into a department, taking the layout, methods, and equipment virtually as they were, then establishing standards for wage-incentive purposes has been completely discredited. In those cases no organized effort was made to standardize methods for performing work and then training the workers in those methods.

The fact that a wage-incentive system can be only a sustaining mechanism and not an attaining mechanism was not recognized.

Every job should be carefully analyzed and simplified before time studies are taken and a standard established; in fact, this is such an important point that I believe an absolute policy should be laid down, with the full burden of proof placed on anyone wanting to deviate from this policy. The policy might read as follows:

> "No standards shall be established on an operation for incentive purposes until that operation has been subjected to a study involving the use of methods-improvement techniques and the results of that study placed into effect in a satisfactory manner."

6 *Failure to guarantee standards once established against change unless there is a change in method, equipment, or specification.* This of course was rate cutting. We know now that a standard must be guaranteed against change unless it be a justifiable change, and then only that portion of the standard involved should be altered, and only to the proper degree. Changes made on any other basis should be made only with the full knowledge and agreement of the employees concerned.

Another variation of rate cutting was to establish a ceiling on incentive earnings above which an employee should not go, or could not go, or the standard would be cut. We know now that the only ceiling that should ever exist on a properly set standard is that of the best efforts of the highest-skilled most ideal worker on that job.

7 *Failure to analyze and establish standards for materials and spoilage.* This failure led to confusion and strong differences of opinion. Often unusually high production was obtained through excessive use of materials, and then when management attempted to correct these errors, they were often charged with rate cutting, and in many cases rightly so. We know now that rigid specifications and quality standards must be established. Production must not be increased at the expense of quality. Clear complete specifications and adequate quality control will do much to insure harmony on this vital phase of the wage-incentive plan.

8 *Failure to properly and continuously maintain measured standards and wage-incentive installations once they are established.* The rigid maintenance of an incentive plan is essential if it is going to be successful. It used to be common practice to forget all about an incentive plan after its initial installation except for annual or some other set period check-up. At these periodic intervals attempts were made to take up all the slack that occurred in the interim.

This meant that loose standards were tightened for no apparent reason other than that a date had been reached. The changed conditions that made the standard loose may have been in effect for months. It was very difficult to convince the average worker that the standard should be changed at that later date. The opposite situation of a standard's no longer being adequate was also found. Thus the plan had become unbalanced and ill-fitting, with all the problems of its administration such a situation involved. No matter how carefully and completely the installation and all that went before are made, the conditions that exist at the time will not remain static. Every change in specification or method should be followed up immediately and the effect on existing standards measured. If it is a controllable change its effect on standards and quality should be checked before it is made.

A company which now has incentive plans in operation should carefully review its history in the light of these points we have just raised. A company that is contemplating using incentive plans must keep these past mistakes in mind in laying down the policies that will govern the development and operation of such plans in its organization.

In so far as the incentive plan itself is concerned, it must be tailored to meet each situation. There is no one plan that is universal in its application in all its details. Therefore without attempting to discuss any particular type of plan, let us consider some of the features and requirements that can and should be used as measuring sticks of the desirability and completeness of any plan that may be developed.

1 The plan should reward the employee in direct proportion to increased output.

Justly or unjustly, the worker does not like to share the direct result of his greater output. The worker feels that fair standards should be established and once he meets and exceeds those standards he should receive the full benefits therefrom. Thus any part-payment plan is faulty in this respect.

This is a logical conclusion, not only from the viewpoint of the worker but also of the management. It presupposes that the plan is on a sound and equitable basis; therefore the worker is entitled to the full gain from exceeding standards, and management should provide maximum encouragement for him to exceed them.

In my opinion the day of the so-called "split plans" is past. From my own experience, and based on my conversations with other engineers, I know of no instance, with the possible exception of some of the process industries, where the straight piecework or straight bonus plans will not fit and prove equitable.

2 The plan should be understandable and easily calculable by the employee.

The worker must be able to calculate his own earnings. Any plan that is not understood or easily figured by the worker is looked upon with disfavor and distrust. Any plan, no matter how complex or how simple, that is designed to limit earnings will finally be detected with most unfavorable results.

3 Hourly base rates should be guaranteed.

Since a wage-incentive plan is designed to offer a financial incentive for a worker to produce work of an acceptable quality over and above a specified quantity, it presupposes that the worker will be fairly and adequately compensated for his efforts and output up to and including that specified quantity. This basic payment for work performed is usually called the base or job rates.

This base rate is the one established by job evaluation and is in accordance with the rate structure and is not an arbitrarily chosen lower rate. There should be but one base rate for a job regardless of whether or not it is on incentive.

While there should be enough spread between the guaranteed base rate and the normal earned rate to provide incentive to extra effort or sustained effort, this can be too large as well as too small. When too small the incentive to produce is lacking; when too large it may be ineffective because the reward for increased output starts before the increased output is discernible. This results in higher unit labor costs. What this spread should be is largely a matter of opinion. I would recommend that it be 25 per cent, with 20 per cent the minimum acceptable spread, and 30 per cent the maximum desirable spread.

In this connection it has been brought to my attention that a few companies, in an effort to overcome the abnormally low rates of output now existing in their plants and the resistance of their workers to increasing these rates, are lowering their re-

quirements for a normal day's work. In other words, they are deliberately reducing the amount of production required to earn the base rate and thus are starting the payment of incentives at a lower than normal rate of output in an effort to overcome these restrictions.

While I have not met such a situation personally, I am assured that it is being used sufficiently to be considered alarming by all competent engineers. If any company is using such a device it is surely to be deplored, because it is saddling itself with higher unit costs permanently and harming the respect that its workers hold for its ability to establish just standards, and by such a weak approach to such a major problem is seriously impairing its entire collective-bargaining position.

We must not under any circumstances permit our conception of what constitutes a fair day's work to be influenced in this manner or in any other similar one.

4 It should provide enough of a guarantee of standards to give the worker a feeling of security.

The standard must be guaranteed against any change except where there has been a definite change in methods, tools, equipment, specifications, or materials that affect the rate of production. This guarantee must be meaningful and strictly adhered to and when such a change is measured, only that portion of the standard directly affected should be changed.

It is not always easy to live up to this policy because many of the changes are of the creeping variety. However, they can be handled if the plan as a whole is being carefully maintained. The engineer in charge or one of his assistants played a major role in effecting the change or at least knew that it was being made. If this creeping change affects the standard less than 10 per cent, I would recommend that the effect be measured and noted on the standard specification sheet but that the standard itself not be changed. Then as these creeping changes are accumulated and affect the standard as a whole at least 10 per cent, the whole accumulated change in standard be made at that time. Of course, each recording of a creeping change and the final change in standard must be fully and clearly discussed with the workers involved.

5 Definite instructions covering policy and methods should be provided.

Management must unfailingly define and establish policies as to what it will and will not do, and what employees may and may not do. A weak or vacillating policy or group of policies can do irreparable damage in all phases of wage administration. In all cases where the line is not clean-cut as to what is fair, rule in favor of the worker.

6 Shop procedure should be standardized. This includes material and equipment requirements, clean-cut specifications, production control, and standard operating instructions in addition to the other phases of good shop control.

7 Measured standards must be based on definite quality requirements, with proper and direct controls placed over waste. This is an essential factor in the development of any standard and must be clearly and specifically set forth, with definite methods of measurement given.

8 Equitable adjustment for failure to meet the task when the cause of the failure is beyond the employee's control should be provided.

By placing the responsibility for each failure where it belongs, management not only indicates its fairness to labor but also focuses attention on organization weaknesses and insures the institution of corrective measures.

9 Once production is such that bonus is earned, unit costs should be constant. This is particularly desirable from a cost and budget standpoint.

10 To be effective the plan must be rigidly maintained. The most essential practice in the operation of any incentive plan is its maintenance.

REACTIONS OF WORKERS TO TECHNOLOGICAL CHANGE

Let us now discuss the reactions of workmen to technological change, wage incentives, and measured output in general.

We can find volumes of evidence in management literature that technological change is good for the national economy and for the American people as a whole. There is no argument on this point in my mind; but I think that the tremendous strides we have made in making this the greatest industrial country in the world, with the highest standard of living in the world, has blinded us to many vital factors that are so much a part of this picture.

The key to this problem of technological change is not the effect on the mass of our people but the effect on the individual, and it is our effort, or rather lack of effort, to protect the individual against economic harm in making our technological changes that has led to the great resistance to them.

When we stop to analyze the single greatest element in employees' resistance to wage incentives and technological change, we find it to be fear. This fear takes many turns but all of them are surmountable and removable.

Analyzing this fear, we find that it is the unknown elements, the mystery that so often in the past surrounded this work, that are largely responsible for it. Workmen have a right to be and want to be in the "know" regarding anything that vitally affects them. Therefore it should be a fundamental policy that before any work is done the workers be fully informed about what is to be done, how it is to be done, and the goal set. Furthermore, as each step is taken, it and its results should be fully discussed with them and progress be made only as fast as the workers can absorb and assimilate it.

This fear and its accompanying resistance usually take the following patterns:

1 The job will be de-emphasized to the degree that their skill and knowledge are no longer economic assets to them.

2 That they will be required to work at a pace they cannot maintain without injury to their health, causing them to age prematurely.

3 There will be a reduction in the force, which will throw them out of work.

4 If they do not meet the standards every day, they will either lose their jobs or be demoted.

5 The rate will be cut as production increases so that they will have to turn out more and more work for the same money.

The degree of acceptance of technological change and wage incentives can be measured almost in direct proportion to the degree of success the management of a company has in developing and establishing policies that meet and overcome these natural fears on the part of workmen.

Therefore before any industrial-engineering work is done, general management must have its policies and thinking concerning the program and its results well in hand before the program is started. It must be prepared to express and discuss its policies with the employees in a clear concise manner before any actual work is done. Some of the subjects that should be included in these policies are as follows:

1 The general objective of the study:

To so simplify and organize the work in a department or plant that waste will be eliminated to the degree that costs are lowered, the product improved, and the company's competitive position improved for the general good of all concerned.

To protect to the maximum degree the jobs and earnings of all employees concerned. To provide an opportunity through

a sound incentive plan for the employees to increase their earnings over and above their base rate. To keep the employees fully informed at all times and to make them partners in the study to the maximum degree practicable.

2 Job security:

No one will be laid off as a direct or indirect result of this study. Should anyone be released from his duties by this study, he will be given plant-wide seniority and every effort made to re-establish him at his highest skill. Any excess labor remaining will be placed in a pool until such time as normal labor turnover reabsorbs them into regular jobs.

3 De-emphasis and dislocation of skills.

De-emphasis of skills does not necessarily follow such installation. Just as frequently a greater concentration of skill use results from proper organization of the work. Should the requirements be lessened to a degree that the economic value of the job is materially lessened, then every effort will be made to transfer the workers to other equally skilled jobs or to find other means of maintaining their take-home pay.

When due to a change in job content skills are disrupted, formal programs to train the workers in the new methods will be established. Ample time will be allowed for this purpose and earnings will be fully protected during the training period. Strong efforts will be made to keep assignments in line with each worker's capabilities and interest. Should a worker, as a result of such a cost-reduction program, decide that he does not wish to be retrained in skills other than his particular one, the company will make every effort to obtain work for him with another company in the skills he possesses. During this search program he will remain on his job for a definite maximum length of time. If at the expiration of that maximum length of time the worker and the company have both been unsuccessful in locating a suitable job, then the worker may either change his mind and be trained in another skill or an adequate and equitable separation allowance may be made at the time of his leaving the company. The option should be that of the worker.

4 Establishment of work standards.

All standards will be set in a fair and equitable manner. The output requirements will be established on the basis of what an average man suited for that type of work can or should produce.

Realizing that errors in judgment can be made, formal appeal channels to the foreman will be established. All appeals will be checked as soon as possible, with earnings being protected by making any changes retroactive to the time of the appeal. Older or slower workers who cannot meet the minimum requirements of the job will be transferred to work more in keeping with their abilities.

5 Performance requirements against standards.

Although consistent underproduction against standards proved in practice could not be permitted, nevertheless it is recognized that standards may not always be met. Variations in the output will be analyzed and efforts made to overcome controllable causes. When variations are a result of the worker's physical or emotional condition, the supervisor will work with him, and suitable solutions will be reached.

6 Rate cutting.

All standards will be set with care. No standard will be changed without good and sufficient cause. No standard will be changed without due notice to all concerned, with full explanation of the reasons given.

I am certain that if a management would develop these and other policies to fit its particular needs, live up to them, and make them live vital things, that it would find its employee relations rising to a much higher plane, and much of the resistance to technological change and wage incentives will disappear.

A phenomenon of unknown portent has entered the industrial picture within the past decade. This condition is the marked trend toward union participation in fields of industrial management heretofore considered to be exclusively the province of the managers of the business. Many unions are militant in their demands for an equal voice, or at least a veto voice, in the features of a business that directly affect them, such as rate of output, rates of pay, working conditions, and the like. If this trend is properly controlled and guided it can be a vital force in back of our next great industrial surge forward. If uncontrolled or improperly used, it can disorganize and disunite the combined efforts of all who are interested in furthering our industrial system to the point where irreparable damage is done.

When we are discussing wage incentives we must include an analysis of this matter of union participation in the setting of standards and developing wage-incentive plans.

Looking at it objectively, we must admit that a co-operative effort has a much greater chance for success than does one that is not co-operative. We have discussed earlier the mistake management made in not making its employees partners in a practical degree in its plans for cost reduction. Now that it is being forced upon management in many cases, it behooves us all to consider just what is a proper relationship for this joint collaboration.

In considering a basis for union participation in the development and institution of such projects as a wage-incentive system, there are certain fundamental concepts of responsibility and authority that must underlie this relationship and must be fully considered.

These are in addition to the mutuality of interest and personal attitudes, concepts and policies that provide a proper, broad, general basis for a satisfactory relationship. These concepts are not affected by the degree of participation decided upon but again are fundamental. These are:

1 The final power of decision must rest with management. Management, if it is successful, must protect and foster the interests of both the employees and the owners of the business. If one is favored over the other to any degree for any period of time, the enterprise is certain to suffer to the detriment of both groups.

Therefore the final power of decision, even as to whether or not the project should be continued, must rest with management. It alone is held responsible for the ultimate success of a business, with the penalty of removal if it fails. It alone can and should be in possession of all the facts, in a corporate sense, of the business, and with that full knowledge is in a better position to make that final decision.

Should the union representatives disagree with management, they must not possess the power of veto or decision. Formal grievance procedure should be set up to provide labor with a full hearing. This may include the calling in of an outside specialist to review the data and give an opinion. However, in no sense should this be construed as arbitration.

2 Policies governing the work of the participants must be clearly stated before any work is done. Careful thought should be given to these policies to make them as complete and comprehensive as possible. At the same time care must be taken to avoid commitments that it may not be possible to keep.

3 A standard must be based only on facts and changed only by facts. Work standards must be based on facts determined by careful and complete analysis. They must represent the best judgment of the ablest technicians available. These individuals must not be subjected to pressures from any source that could be interpreted as attempts to influence their decisions in favor of one party or another.

Standards may be questioned only to the degree that further analysis is desirable either to support the standard or to provide

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Is the ENGINEER *a* LONE WOLF?

More Explicitly, Is He a Slacker in the Discharge of His Civic Responsibilities?

By ROY V. WRIGHT

PAST-PRESIDENT AND HONORARY MEMBER, A.S.M.E.; CHAIRMAN, ENGINEERS' CIVIC RESPONSIBILITIES COMMITTEE

THE engineering profession, like some others, is not noted for the extent to which its members discharge their civic responsibilities in this representative democracy of ours. Science and engineering have conferred vast benefits upon civilization; have raised standards of living to heights unthinkable a century ago or less. Improved communication and transportation have reduced the world to a relatively small compass. Because, as individuals, we have become so interdependent, on both a community and world-wide basis, these almost miraculous developments have brought with them the most serious complications in our economic, social, and political life.

A LONE WOLF?

The charge is made that the engineer is too indifferent to these problems, for which in certain respects, at least, he is partially responsible; and many of which can best be solved by the same type of approach, research, and logical analysis that he applies to his own work. Because of this indifference the engineer is being charged, inside his own profession, with being a lone wolf.

Listen, for instance, to this statement in a letter to the A.S.M.E. Engineers' Civic Responsibilities Committee from a well-known dean of one of our engineering colleges:

"Is the engineer naturally a lone wolf? Recently I talked at a Rotary luncheon at a neighboring city and the program chairman said that in all his years in Rotary he had never heard an engineer address a luncheon meeting. I have been on many committees, such as chambers of commerce, governmental planning, and fund raising, but I have had very few engineering colleagues on these committees. I wonder whether I am a typical engineer or not. I think the Committee will have to either change the nature of the engineer, or find something in civic work that offers an urge to action for the typical engineer as he is."

So much by way of introduction.

A.S.M.E. CITIZENSHIP ACTIVITIES

This Society for many years has had a citizenship committee. In its earlier stages it was more concerned with the student members and tried out several experiments to stimulate a greater interest in responsible citizenship on the part of the engineer in training. Within the past three years (partly because of the effect of war on our student programs) it has approached the problem from a somewhat different angle.

In the fall of 1943, it sent a letter to each of the 70 Section chairmen, asking them to designate an individual or appoint a committee to co-operate with us in making a high-spot survey to determine the extent to which members of the Society are active in governmental or civic affairs beyond professional work for which they are compensated. Twenty-seven replies were received but very few named individuals or committees to co-operate with us.

At the same time letters were sent to the honorary chairmen of the 115 Student Branches, requesting comments and suggestions as to the most practical and constructive means of stimulating a greater interest on the part of the Student Branches. Nineteen replies were received.

MEASURING STICK FOR RESPONSIBLE CITIZENSHIP

The net result was that the committee drew up a tentative measuring stick for the participation of engineers in civic affairs. This was sent to those Sections which had responded to its earlier request; it was felt that this was the most fertile ground upon which to experiment. These Sections were asked to furnish us with thumbnail sketches of members who were taking an outstanding part in civic affairs. The result was distinctly disappointing. Two Sections put forth some real effort to co-operate, but at the end of three months information was received covering only nineteen individuals. These sketches, however, were helpful in checking the adequacy of the "measuring stick."

The next step was a direct approach to two Sections, Washington and Cleveland. Each of these Sections devoted a meeting to the subject of "Responsible Citizenship," and the activities suggested by our committee. There were extended discussions in both instances which developed considerable practical information that led us to believe we were heading in the right direction.

THREE CHALLENGING QUESTIONS

This stage of our campaign culminated in arrangements being made for a consideration of our program at each of the eight two-day Regional Local Section Conferences held in May and June of 1945. The three questions proposed for discussion at these conferences were as follows:

1 To what extent do our members participate in civic and governmental affairs? Is the yardstick suggested by the A.S.M.E. Engineers' Civic Responsibilities Committee sufficiently clear and comprehensive? How can we secure the co-operation of the Local Sections in making such a survey of their members?

2 How can we best locate an interested member or small committee in each Section, or community, to co-operate as a local representative of the Engineers' Civic Responsibilities Committee, and help to awaken an interest and develop programs in each Local Section?

3 What is each Local Section or local engineering society (if the Section functions with such a society) doing to assist the community in solving engineering and related problems?

It was impractical to have members of our committee at these eight discussions and, undoubtedly, in some instances, the conferences did not have the proper background or sufficient information available for the most constructive consideration. The results were a bit spotty, but gave some room for encouragement.

BARRAGE OF BULLETINS

Then came a spirited drive. At ten-day intervals, from near

the end of August to the middle of November, 1945, 200 key members of the Society were subjected to a veritable barrage of bulletins leading up to a Citizenship Session, including also a luncheon program, at the Annual Meeting in November, 1945.

The bulletin service was originally intended as a clearing house for the members of the committee, since it was impracticable to hold more than occasional meetings. All of the 200 people on the enlarged mailing list were urged to send in their criticisms and comments for the guidance of the committee. As the net result of the earlier efforts and of these bulletins, and the Annual Meeting, here is, roughly, the status today:

PERSONAL QUESTIONNAIRE

The so-called "Responsible Citizenship Measuring Stick" was revised and put in the form of the accompanying questionnaire.

A.S.M.E. ENGINEERS' CIVIC RESPONSIBILITIES COMMITTEE PUBLIC SERVICE QUESTIONNAIRE

Explanatory—Co-operation by replying to this questionnaire will be most helpful (whether positive or negative) and will be greatly appreciated by your committee, which has been charged with developing a program to awaken our members to a greater sense of civic obligation and responsibility.

Name (Please print)...

Address...

I—Do you hold or have you held appointive positions on public boards, committees, commission, etc? If so, What? When?
- Town or City...
- County...
- State...
- Federal...

II—Do you hold or have you held elective public offices? If so, What? When?
- Town or City...
- County...
- State...
- Federal...

III—Are you an active member of a political organization? In what capacity?
- Precinct Committeeman...
- Ward or City Organization...
- County...
- State...
- Federal...

IV—Do you assist or advise your elected representatives? Orally or in writing?...
- As a member of the legislative committee of any group, association, or organization? What group?......................

V—Are you actively engaged in any civic or community activity? What? How?
- Welfare...
- Educational...
- Spiritual...
- Character building...
- Artistic...
- Recreational...
- Community Planning or Civic Improvement....................
- Business—Chamber of Commerce, for instance...............
- Labor Union or Human Relations in Industry................
- Service Club...
- Other helpful or worth-while activities...

....

VI—Remarks

PLEASE NOTE: The purpose of this study is not in any sense to butt in on your privacy or personal affairs. Our nation, as you undoubtedly recognize, is faced with many serious and complicated problems which demand the attention and best efforts of every intelligent citizen. If we can secure an accurate and clean-cut picture of the attitude and practices of all our members it may be possible for us, as an organization, to set up a program that will encourage a larger participation of engineers in public affairs, at the same time enhancing their prestige—professional and otherwise—in the community.

We hope, with the co-operation of our eight regional vice presidents, to apply it to a typical Section in each region. This should give us a better idea of the problems to be faced in making our members more citizenship-conscious. The Durham (N. C.) Engineers' Society is testing it out. We do know that among the 200 individuals who have received our bulletins, it has had some beneficial results in the direct personal challenge it has made to them. Here is what some of them have reported:

"This questionnaire brings forcefully to mind how inactive I am in public affairs in my community. Good idea!"

"Keep up the good work—it is needed."

"Confession: Generally speaking, I haven't touched the fringe of public service which individual citizens owe for the privilege of living in this country."

The suggestion was explored of preparing a citizenship manual for the stimulation of the Sections in building their programs. A statement of principles was prepared, but it was felt that this should be strengthened by citing practical examples of good work done by some of our Sections, individually or in co-operation with other groups. Such material is being assembled, but meanwhile the committee bulletins have served to fulfill this requirement.

ENCOURAGING YOUNG ENGINEERS

It was suggested that special efforts should be put forth to encourage young engineers to take a more active part in civic affairs, and that a medal be awarded for Junior achievement in this respect. There is some skepticism as to whether any young engineers can be found who will qualify; a sad commentary, but not entirely true, for a few of our engineering colleges have been busy in recent years in giving instruction in citizenship. We do know that some of our younger engineers are giving an excellent account of themselves in civic affairs. The task now is to find the wherewithal to set up such an award and to promote it.

SUGGESTED READING LIST

In its efforts to assist the young engineers to continue their studies and broaden their understanding and vision, the E.C.P.D. has prepared a reading list of books dealing with natural science; philosophy, including religion; economics and sociology; psychology; business and industrial management; literature, including poetry, essays, and fiction; history, biography, and travel; fine arts, etc. Strange as it may appear it contains little, if anything, relating to political economy and citizenship—matters of prime interest to every American citizen, and particularly applicable to the engineer in the light of our A.S.M.E. Citizenship Committee studies and findings.

The committee suggested a tentative reading list in one of its bulletins. Some suggestions have been made for additions to this list. When these books can be checked for their practical value, the list will be completed and made available. The point stressed in its preparation is that the books must be practical from the viewpoint of responsible citizenship, and must be readable by the people for whom they are intended. Deep and profound treatises, understandable only by experts in the field of political economy, and theoretical discussions will be avoided.

THE STUDENT ENGINEER

What to do, in a practical way, for the student engineer is a baffling problem. Among the 200 key men on the bulletin mailing list, however, are many engineering educators. They are interested in both Section and Student Branch activities. We are expecting much from these educators in discovering ways and means by which we can be helpful to the student groups. The committee anticipated, in its attempt to locate "citizenship-

conscious" members in the various Sections, that these members would find ways and means of getting in contact with and being helpful to the Student Branches in their vicinity.

It will mean much to the students if they can meet and discuss civic and citizenship problems with practicing engineers who can talk from actual experience about participation in such affairs. In my own experience in speaking at Section meetings, I have been delighted with the number of student members in attendance and the interest they have shown in discussions on responsible citizenship.

Summing up, the problem we are trying to solve is twofold: (1) How to stimulate a greater interest in civic and governmental affairs by our individual members, Student, Junior, and older; (2) how to stimulate our Sections, either by themselves or associated with other groups, to be more helpful to their communities and to the government, local and otherwise, in providing the necessary common services and protection on a sound, efficient, business basis; that, after all, is the purpose of government.

INDIFFERENCE THE CANCER THAT DESTROYS

It would be well if we could all give some time to the study of "Why Democracies Fail." Indifference on the part of otherwise intelligent citizens is a cancer which slowly but surely destroys.

The late Hendrik Willem Van Loon in a syndicated series of articles on "The Story of Democracy," reminded us that Plato said 2500 years ago that autocracy is the result of bad democracy. He climaxed his article with the statement: "For, alas, none of the leaders seems as yet to have learned that democracy, being the most difficult and complicated form of government ever devised by human ingenuity, can be maintained only by constant watchfulness on the part of all the citizens and by a most careful scrutiny and selection of those whom they wish to recognize as their leaders. Without that unselfish devotion to the interest of the community at large, all democracies are bound to end in a dictatorship."

To what extent are we engineers, as a well-educated intelligent group, rendering that type of service to our communities and nation? Is it true that we are, in fact, lone wolves, who are so deeply engrossed in our technical and business problems that we overlook the most important factor in a democracy such as ours—Responsible Citizenship?

Wage Incentives

(*Continued from page 716*)

the basis for making a change. If such an analysis supports a standard it must remain unchanged. To permit a standard to be changed arbitrarily because of pressure exerted by a group is to destroy the integrity of all standards and to cause them to be subjects of mistrust. Therefore standards must not be subjected to negotiation or arbitration, either in their establishment or in their change.

4 The fundamental reason for making the study should be fully stated. We mentioned this earlier but it deserves emphasis again, as it is important that protection be provided against future misunderstandings. The reasons for the study may include such facts as the company's poor earning record, the type of wage plan in use not being satisfactory, an effort to provide more stable employment, and the like.

At this time the goals or objectives of the study are clearly defined and established. The program outlining the step-by-step progression toward these goals should be drawn up and agreed upon by all parties concerned.

Actual participation can vary all the way from a purely advisory and interested position to that of representatives of the employees working full time with the engineers in an effort to reach satisfactory and equitable solutions to the problems. The degree of participation would depend upon the employee's measure of interest in participating beyond a "being kept informed" point and also upon the degree of maturity and confidence reached in this relationship between management and labor. Management and labor must approach these problems in an intelligent manner. They must determine a sound basis to establish their spheres of interest. If this is not done then indeed the future is dark.

Both management and labor must recognize that wage incentives are and can continue to be a valuable tool of management in its efforts to reward its employees properly and fairly and to control its costs. As such a tool, incentives will play an important part in our peacetime economy. It is therefore essential that both management and labor consider the proper development of wage-incentive plans and their use so that each party will receive the maximum benefit from that use. It is up to management to point the way.

BLIND WAR VETERAN OPERATES MACHINE AT BUICK

(A totally blind war veteran, Harold Wesley Marston, 28, is doing a creditable job as a machine operator at the Buick Motor Division plant at Flint, where he was employed before the war. He is shown sliding a selector control rod in the slot of a small punch press.)

The PATENT SITUATION *and* SOCIETY

By EMANUEL R. POSNACK[1]

TWO and one-third million inventions have been granted the privilege of patent protection in the United States. That these have played an important role in the industrialization of America cannot be denied. Indeed, our comparatively high standard of living can in large measure be attributed to American inventive genius. It would thus seem that our patent laws have successfully carried out their mission "to promote the progress of science and the useful arts," as stated in the Constitution.

Yet today, after one hundred and fifty years of operation, the patent system is being attacked. The consumer is critical of the system because he believes he sees a tie-up between patents, big business, cartels, and high prices. The individual inventor is dissatisfied because of the ease with which his patent can be avoided by infringers. The small businessman is displeased because he cannot compete with large patent-pooling combines. The industrial titan is complaining because he is convinced that he is being discriminated against by the Patent Office and the antitrust attitude of the courts. There is also the widely prevalent conviction among most people that they are being deprived of the full benefits of our advanced technology by the "suppression" of patents.

Indeed, so widespread is the criticism of the patent system that President Truman has formed a committee to investigate the situation and make recommendations for reform. The appointment of this committee is in addition to the National Patent Planning Commission appointed by President Roosevelt by Executive Order 8977 which received wide publicity.

PUBLIC'S STAKE IN PATENTS

It is becoming increasingly apparent that the public has a big stake in patents, that our patent system is closely interwoven with everyday life. Its influence extends into every phase of modern enterprise and affects every aspect of living. Its manifold paths lead into industrial empires where state-created legal monopolies hold sway, as well as into the wide field of invention that covers the countless materials, services, processes, machines, and "things" which constitute the fabric of human society. It is the concern of all who are part of the economic life of this nation, and of the entire world.

The inducement offered by our Government as a stimulus to invention is not in the nature of a money grant. For the Government is interested not in using inventions for its own purposes (except in some special cases and during war emergencies), but rather in encouraging their exploitation by private industry. In a socialistic economy, as in Russia where the State owns all the means of production, direct government rewards may be advantageously offered. But under an economy of private enterprise such as prevails in our country, the monetary compensation must be derived through the exploitation of the invention either by the inventor or the investor. Inasmuch as such exploitation necessarily involves a financial risk in a new and untried project, the inventor is given an opportunity to engage in the business of selling his invention in a field cleared of competition. In other words, by direct authority of the Constitution, an exception is made to the conduct of business within our society of competitive enterprise in that the inventor can remove competition by virtue of what amounts to a Government-granted patent monopoly within the scope of his invention.

RIGHTS OF THE PATENTEE

The patent is limited to seventeen years, and gives the patentee the right to exclude all others from making, selling, or using the invention during that period. After the expiration of the patent, the invention passes into the public domain. But during the life of the grant the owner of the patent has complete control over his invention. He may use it or pigeonhole it. He may exploit it himself, or arrange for its exploitation with others, individuals or groups of individuals, firms or groups of firms, or cartels.

The justification for granting the special privilege of monopoly to the creators of intellectual property such as inventions has both an ethical and a practical basis. Inventions are contributions of something new to the world's common store—something which never before existed. Hence, unlike other forms of known things for which there has been an established demand, the monopoly in an invention deprives the world of nothing. By refusing to accept the bounty of the patented invention, which it may freely do, the world is no worse off than before. By accepting it, the world has acquired an addition to its store of wealth.

Inventions are a form of wealth quite unlike that which is to be found in the bowels of the earth, or which can be produced through the physical exertions of the human body. For both natural resources and human energy are necessarily limited in accordance with the dimensional limitations of the earth and the known limitations of human strength. But inventions, stemming from the boundless extent of the human mind, can flow on forever, without limit.

It is to activate this limitless source, the human mind, that the extraordinary inducement of a limited monopoly is thus offered.

PATENT ABUSES

Wherever government franchises or monopolies hold sway it is generally not difficult for abuses to appear. And the patent monopoly has been no exception. As industry expanded during the technological development of this country, there was a gradual enlargement of the domain of the patent monopoly, until many large patent-owning concerns were able to control, along with their patented inventions, unpatented parts and supplies incident to the use of the inventions. In other words, the patentees' powers, by actual court sanction, began to extend into the public domain, the field of unpatented goods.

[1] Patent Lawyer, M.E., LL.B. New York, N. Y. Author of "The 21st Century Looks Back," William-Frederick Press, New York, N. Y., 1946.

Operating within the public domain were large numbers of independent ventures. Their numbers kept growing, as would be expected in a society of more or less free competitive business. With the progressive expansion of the patent domain the rights of more and more independent enterprises were being invaded. They began to resist and battle, and during the last thirty years have gradually succeeded in reversing the trend and contracting the patent domain to more tolerable proportions.

Today, as the result of this reversed trend and recently adopted antimonopoly attitude of the courts, the very same patent laws which had previously made the patent owner a king in his domain, have been substantially reduced in their scope. For the public is now regarded as a party in interest.

The present-day interpretation of the laws is such as to keep the patentee within the terms of his grant; and when he steps beyond he is denied the use of his greatest weapon, the injunction, against an infringer. In other words, if a patent owner should misuse his patent he cannot successfully sue an infringer as long as such misuse, or its effect, continues. By misuse is meant unlawfully attempting to monopolize or even partially monopolize unpatented things, suppressing competition by unlawfully restricting the resale price of a patented commodity, and expanding the patent monopoly by employing it to control other fields.

It is the misuse of patents that has been largely responsible for the noticeable public antipathy toward the entire patent system and even generally toward big business. In a nation where the goal of an economy of abundance seems to be favored by practically every section of the politico-economic spectrum, it is natural for people to resent restrictive practices which throttle production, induce an economy of scarcity, maintain high prices, and tend to lower the general standard of living. Because in certain large-scale trade-restraining projects patents play an important part, there are many who would with a single stroke sweep away the entire system of patents together with those other monopolies against which our antitrust laws are directed.

DANGER IN CURTAILING PATENT RIGHTS

The author believes that such a tendency is a real peril to a system which has successfully served as a stimulus to creative effort, which has provided the fuel to motivate the wealth-producing mechanisms of manufacture and commerce. The patent-busting proposals directed against the basically sound system *per se*, rather than against the abuses of the system, would reduce to a mere trickle that great stream of inventive thought which has so richly contributed to this man-made world.

It is in the power of the people of a democracy to legislate out of existence competition-stifling practices without impairing in the slightest the effectiveness of patents as a medium for stimulating inventive effort and creating new ventures. The gist of the system's evils resides in the legal right of patent owners (1) to limit production, or the field of use, of a patented commodity or process, (2) to arbitrarily set high prices on a manufactured article so that resale and consumer prices must necessarily be high, and (3) to refuse to exploit an invention, that is, to suppress it. These restrictive rights are rights arising through the operation of law, and they can be completely eliminated by the passage of suitable counteracting laws.

If a patent owner, whether an individual or an international cartel, were prevented by law from entering into an agreement setting a ceiling on production or a floor on prices, many of the evils complained of would disappear. And if in addition the unwarranted nonuse or suppression of patented inventions (after an initial few years of grace) were outlawed through the compulsory licensing, to the highest bidder, of patents in unexploited territories and for unexploited uses, the world would benefit immediately by every technological advance. This would not in the slightest affect the right of big business to operate where bigness is necessary.

The misuse of patents which we have thus far considered presents merely one side of the picture, that depicting the supercharging of patent rights, which gives the patent owner an undeserved strategic advantage in a field of competitive enterprise. The other side of the picture shows the undermining of patent rights which gives the patent owner an asset of questionable value, and which often places both the inventor and the investor relying on the patent grant in a precarious position.

Indeed, due to the attitude of the courts, large numbers of patents have become no more than mere scraps of paper. For, although it is the Patent Office that issues a patent, it is the courts which pass on its validity when it is brought to test; and more often than not the courts decide that patents are invalid and hence worthless.

THE FEDERAL PATENT MUDDLE

The core of this contradictory situation is the confusion which exists as to the very definition of invention. In our country, the most prolific producer of inventions, the extent of this confusion is amazing. Not only is there disagreement between the Patent Office and the courts, but there is similar disagreement among the more than one hundred federal district courts and appellate tribunals.

Today a patentee or an operator under a patent is penalized because he has seen fit to rely on the Patent Office as the national authority on patent matters. He invests his time, effort, and capital in the development and exploitation of an invention because of a monopoly grant by the Government, only to have the courts take away the monopoly when the patent is put to the test.

Through the eyes of many a patentee the situation is as follows: The Government induces him to disclose his invention to the public, in return for which he is offered a limited monopoly. He accepts the offer. A few turns of the Government machinery and the inventor has his monopoly, and the public is free to inspect his invention. A few more turns of the Government machinery and the inventor has lost his monopoly and the public is free to use his invention.

The patentee feels he has been cheated. He does not understand the Government patent-issuing and patent-adjudicating machinery, for he is not a patent lawyer. He does know, however, that he was induced to part with something which belonged to him, that it was the Government that did the inducing, that made the offer, and that deprived him of the promised reward after he had performed his part of the contract. This, to him, closely resembles a fraud.

When a patent gets into the courts its validity is almost always under scrutiny. The attorneys of the defendant accused of infringing the patent microscopically examine domestic and foreign patents and publications, often going back to the dim past in their investigations, in search of fragments of ideas that bear some resemblance to the elements of the patent in suit. When the judge is finally confronted with this mass of evidence, he generally comes to the conclusion that the "flash of genius" is lacking, or that the alleged invention is after all no invention at all, and hence not entitled to patent

protection, despite the fact that the Patent Office had thought otherwise.

This situation illustrates the existing state of confusion as to the very meaning of invention, and it brings to the fore the question as to the need of a new philosophy in the evaluation of inventive thought and in the determination of a uniform test or a patentable invention.

MERIT OF INVENTION SHOULD DETERMINE PATENTABILITY

Among the specific aspects of this problem the most important is that of supplanting the present subjective test by an adequate objective test, where the determining factor is not the merit of the inventor, but rather of the invention. The criterion should not be, as to a great extent it now is, the ability or genius of an individual; the test should simply be directed to the nature of the product itself.

The erroneous impression seems to prevail that corporations and large research bodies are responsible for most inventions. The Patent Office records clearly indicate that the lone inventor obtains a considerable percentage of the total patents issued in this country. Because of this fact, and also because of the predominance of so-called small or minor inventions even by members of corporate staffs, the test should be sufficiently lenient so as to permit inventions of a relatively low order of magnitude to be protected. If the invention is (1) useful, (2) involves a functional improvement even though it is accomplished through a small mechanical change, and (3) is capable of adding both to productivity and labor employment, it should be granted patent protection. The monopoly privilege can be no greater than the invention. If the inventor's creation does not rise to the level of a high order of inventiveness, the monopoly will be correspondingly limited in value and scope.

The public's interest in a fair and practical test of invention is not confined exclusively, however, to a position in favor of a patentee as when a meritorious invention is involved, but also to a position against the patentee when the invention does not merit patent protection. In other words, when a patent has been erroneously issued, through an oversight or mistake in judgment of a Patent Office examiner, it is to the public's interest that it be relieved of the burden of supporting the invalid patent.

PATENTS USED TO THROTTLE COMPETITION

At the present time it is entirely possible for a patent which is intrinsically invalid to be used by its owner as a threat to throttle competition. Unless someone is willing to go to the considerable expense generally necessary to test the patent's validity in court, the threat may hang over the heads of the patentee's competitors for the life of the patent. Because of the patentee's right to fix prices and restrict production, the public may be compelled to pay a heavy premium for the use of the alleged invention. Indeed, threatened competitors may find it more expedient to accept licenses under the patent than to fight it, thereby participating in the restrictive practices permitted under the law, against the public's interest. There is nothing the Government can do about it, as long as the patentee and licensees operate within the legal bounds of the patent grant. For although a private party in interest may test the validity of a patent, this right is denied to the Government.

Here again is a situation where the patent law is behind the times. While the courts are asserting, more emphatically than ever, that the public has a vital interest in patent grants, the Government as the public's agent is powerless to protect this interest against intrinsically invalid patents.

The obvious remedy would appear to be to give the public, through its Government, certain rights which it does not now possess, to wit (1) the right to initiate a lawsuit to test the validity of a patent, and (2) the right to intervene in patent litigation already pending, to assure an adequate defense, and to prevent collusion between the litigants or a settlement against public interest.

PATENTS ON A GLOBAL BASIS

Many cracks and fissures have developed in our patent system since its inception. There is not a fault in its structure, however, that cannot be corrected by legislation. However, considerably more must be done than the making of mere repairs, for our country is merging economically, albeit rather slowly, with the rest of the world. To improve the system of patents properly, it must be enlarged, on a global scale.

The mechanism for the exchange of ideas on a global basis is already here in the form of the United Nations Organization. The world now needs leaders with the vision and capacity to provide the instrumentalities for putting this mechanism into operation.

The trend toward internationalism is evident even in conservative circles. The American Bankers Association has recommended the removal of hampering barriers to international trade, and has approved a global bank. Can it be said that a global patent authority is more visionary than a global bank? Would not such a body be in an excellent position to provide for a single standard or test of invention throughout the world on the theory that if an idea is truly new, it must be new everywhere? An international authority of this character would be capable of enlarging the geographical domain of a patentee by enabling patent protection to be obtained in any country merely upon payment of a nominal government fee, thus avoiding the tremendous expense of separate prosecution in each country as is now necessary. Under such a system there could readily be produced an international clearing house for the creations of inventors and authors of all lands.

The Social and Economic Council of the United Nations Organization has for its objective the improvement of man's lot through the medium of social-security legislation. Would it not be as justifiable, on purely ethical and human-welfare grounds, to employ a global expedient for releasing the world's store of inventive genius for the enrichment of man's life?

A unified international patent system is a logical step toward world unity, and toward an economy of abundance. It will cause a multiplication of independent enterprises throughout the world; and ideas, labor, and capital will then more readily than ever be converted into going factories, fruitful land, producing ventures, things, and consumable wealth.

The breaking down of the once impassable physical barriers between nations and continents has vastly enlarged the domain of the individual. The sciences of instant communication and rapid transportation have immeasurably increased man's mobility, and have removed time and space from their previous roles as obstacles to the flow of man's goods and intelligence throughout the world.

The technological means now at our disposal are capable of so linking together the minds of men as to produce a fathomless global intellect, a reservoir of ideas which, if actuated and properly channeled throughout the world, would irrigate the fields of human endeavor and raise the level of living of every human being wherever he may be.

Trends in AGRICULTURAL MECHANIZATION

By H. B. WALKER

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AGRICULTURE, now generally regarded as an industry, is still classified by some as a way of life, no doubt because of the large areas upon which it operates; the widespread dependence of mankind upon its products; and the relative isolation of those engaged in production activities. Those of us who are interested in the engineering phases of this industry are called agricultural engineers; not because of any basic difference in our academic preparation for engineering service, but because it designates a field of work peculiar to an industry engaged primarily in the production of raw products for food, shelter, clothing, and materials for industrial uses. Agriculture is basically dependent upon the biological sciences for much of its progress in plant and animal development, and therefore engineering is somewhat incidental and brings into usefulness the physical sciences helpful to the farmer.

Hoover and Fish state in their book:[1] "The agricultural engineer draws upon such principles and practices of civil, mechanical, electrical, and chemical engineering as are applicable to agriculture. To apply them intelligently and successfully he must know also the basic principles and practices of agriculture and must have an impelling interest in the way of life and the problems of the farmer, and the zeal of a missionary in helping him to solve these."

It may be questioned whether the zeal of the engineer in agriculture is much different from his zeal in other fields, for the engineer, wherever he is found, deals in tangible values in the solution of technical problems. However, the problems of agriculture are peculiar to the industry and the engineering approach must take into account the nature of the industry.

In addition to being considered a basic industry, agriculture is also a dispersed one, consisting in this country of more than six million operating units, with more than 50 per cent of all those engaged in agriculture owning and managing the operating end of the business. This of course is quite in contrast to the manufacturing, mining, and transportation industries of this country, but is perhaps more comparable to the merchandising business in type of ownership. The trends in agriculture have been toward more specialization of production, greater opportunities for management, more output per worker, and relatively fewer of our population classed as agricultural. In the latter part of the eighteenth century there were 8 to 9 people classed as rural for every person considered urban. Today for every person living on farms, there are five persons living elsewhere. Thus farm people now make up a minority group that is still growing relatively smaller. As a group in this country they have accepted, either consciously or unconsciously, the responsibility of producing products from the land, so that all may have food and other products in adequate quality and quantity at low cost. This of course implies a fair return to the farmer commensurate with the responsibilities assumed.

Mechanization in agriculture has been an important factor in bringing this about, and much more can still be done to reduce labor and lighten the effort of workers. These developments have been of great value to us individually as consumers, and to our nation from a national-security standpoint. For example, 115 years ago it required 57.7 man-hours to produce a 20-bushel crop of wheat which can be produced in California with 3.2 man-hours.[2] If no progress had been made in farm mechanization and if we were required to pay the 1945 ceiling rates for farm labor to produce this crop, the labor cost alone per bushel of wheat would be over \$2. With modern methods the labor cost is less than 15 cents per bushel. Thus mechanization has provided this basic food product at less cost to the consumer, and the labor involved has received a relatively high rate of pay. Furthermore, with less than 20 per cent of our population committed to agricultural production it has been possible to expand our industries for mass production needed to win a world war.

In 1929 your speaker presented a paper[3] at the World Engineering Congress held in Tokyo, Japan, illustrated with a chart to support the statement that in this country where our farm population was, at that time, about 25 per cent of our total population, there appeared, ". . . . to be no great engineering obstacles in the path of further downward trends, so that by another quarter of a century of power development, it appears likely that in America at least there should be no less than five industrial workers in other lines for every agricultural worker."

This paper provoked considerable discussion and some delegates (Japanese) expressed concern of such tendencies as a matter of national security and stability. Since that time this nation has even bettered those predictions and won a war of world magnitude in which our agricultural industry produced vast quantities of food for itself, its allies, and the conquered peoples. These changes have been possible through the widespread utilization of mechanical equipment, including power, by the farmers of this nation.

LABOR RATES AND MECHANICAL DEVELOPMENTS

Labor saving has been the principal motivating force in agricultural mechanization. The rate of progress in this direction has been influenced by the almost paradoxical trend between labor and power costs. Generally speaking, as the cost of farm labor has gone up, the cost of mechanical farm power has gone down. Since in any farm operation involving large blocks of labor man-labor becomes a power unit to a greater or lesser degree, any steep advance in labor rates creates a strong desire upon the part of the farm operator for machines

[1] "The Engineering Profession," by T. J. Hoover and J. C. L. Fish, Stanford University Press, 1941, pp. 165–166.

Presented at a meeting of the San Francisco Section, April 25, 1946, of The American Society of Mechanical Engineers.

[2] "Changes in Technology and Labor Requirements in Crop Production: Wheat and Oats," by R. B. Elwood, L. E. Arnold, D. C. Schmitz, and E. G. McKibben, W. P. A. National Research Project, April, 1939, Table F8, p. 165.

[3] "Engineering as Applied to Agriculture," by H. B. Walker, World Engineering Congress, Tokyo, Japan, paper 454, 1929, p. 4, Fig. 1.

to take the place of man. Likewise, any advance in labor rates affects most adversely the production costs of crops involving the extensive use of hand labor.

For example, by hand methods of thinning, blocking, hoeing, and harvesting of sugar beets, 102 man-hours of labor are required to produce a 15-ton crop of beets. Ten to twelve years ago this labor was available at 35 cents per hour, or the labor cost per ton of beets was $2.38. Today labor has advanced to 90 cents per hour and where the same labor requirements exist, the labor cost for the 15-ton crop is $6.12 per ton. Furthermore, under the low labor rate, manpower was more plentiful and efficient, while under existing conditions of high labor rates it is scarce and less dependable. Farmers and processors under these circumstances were forced either to seek machines for supplanting hand methods or to abandon production of the crop.

Research and experiment fostered by the sugar industry, the University of California and the federal government and the implement industry have developed through the necessity of crop survival, seed processing, precision planters, mechanical blockers, and mechanical harvesters to a point where it is now possible, in California at least, to produce a 15-ton crop with 35 man-hours of labor instead of the 102 man-hours previously required. Thus it is now possible to produce sugar beets at approximately the same cash labor cost of twelve years ago, but this has been done by mechanical developments which have reduced man labor in terms of man-hours 65.6 per cent.

COTTON PICKING

Cotton is another of our high-labor-demand crops that has resisted mechanization. In California, where our yields are high and our field methods mechanized about as much as any place in this country, it requires 154.4 man-hours of labor to produce 700 pounds of lint cotton per acre; 31 per cent of this is for preharvest work including thinning, hoeing, and irrigation, and 69 per cent is for harvest labor, practically all of which is for picking. The hand methods used today to harvest cotton are approximately the same as a century ago. The necessity of picking by hand has held up mechanization, and the rapid advances in labor rates have placed the growers of cotton fiber in an unfavorable economic position.

Mechanical cotton pickers have been the dream of inventors for scores of years. A patent for a picker was granted to S. S. Rembert and T. Prescott of Memphis, Tennessee, about 1850,[4] nearly one hundred years ago. Many patents have been issued since, but only recently have mechanical harvesters been perfected to a point worthy of economic interest. These are of several types, but the spindle and doffer type operating in drums or cylinders with vertical axes seems to be farther advanced, mechanically at least, than the others. Some of these units have been operated in California with sufficient success to create a demand for others, even though growers realize further developments are needed and will undoubtedly take place with added field experience. Field tests were run with twelve machines of this type in the Mississippi Delta[5] region in 1944 with the following general results. The machines picked up to one bale per hour although the average for all machines was 0.41 bale per hour, and the average area covered was 0.47 acre per hour. The picking cost on 2229 bales was $7.38 per bale of which $3.84 was operating expense and $3.54 depreciation and interest. These costs even taking into account grade loss and shatter, compared favorably with hand methods which in the same area averaged $37.76 per bale. There was a grade depreciation in machine-picked cotton of 1.4 grades and this represented a loss of $18.40 per bale. Furthermore, field losses were 7 per cent more for the machine-picked cotton for which a monetary loss of $7.62 per bale should be charged, making the total machine-picked cotton cost $33.40 per bale or $4.36 less per bale over hand methods.

The remarkable thing about these particular tests is the actual savings under a fairly rigid charge system and the relatively good performance of the machines in maintaining grade. In some cases a grade loss of only 0.8 was obtained by mechanical picking but a maximum loss of 2.2 grades was likewise recorded. The staple length was slightly higher for machine-picked cotton due perhaps to the failure of the machines to recover the shorter weaker fibers. This may have accounted for the increased yarn strength of the mechanically harvested cotton, an advantage which may in time become of recognized commercial value.

Other harvester tests reported in 1945[6] were not so favorable. Drought conditions interfered with boll development and this in turn prevented the spindles from recovering some of the underdeveloped immature locks. The tests last year indicated a grade loss of 2.9, a field loss of over 15 per cent and a much higher picker and card waste in spinning. The yarn strength, however, was higher as was the case in 1944.

In the development of any mechanism for agriculture, the big battle is to get field acceptance, that is, someone who is willing to keep the machine going from the standpoint of profit attraction. The Mississippi tests have demonstrated the economic possibilities in the cotton picker. Improvements will develop rapidly with actual field use and there is every reason to anticipate improvements in grade of picked cotton and field recovery. Apparently we are on the verge of full mechanization of the cotton crop, particularly in California where large farming operations are common. While it is true mechanical picking in itself will not insure complete mechanization, this has been the key bottleneck in mechanization. Precision planting, cross blocking, preharvest defoliation, chemical weed control, and possibly flame cultivation, will contribute to the full mechanization goal. With mechanization it may be possible to pull cotton out of the poverty-crop class. In California this crop is needed for its by-products of oil, cake, and meal—the latter two of great importance for the maintenance of our livestock industry.

HAY NEARING FULL MECHANIZATION

Hay is one of the large and bulky crops of this state which is nearing full mechanization in so far as machinery is concerned. California produces around 5 million tons of alfalfa hay from the million acres of that crop, in addition to other millions of tons of grain and wild hay. Much of this hay is packaged by baling, this requiring in excess of 5000 tons of wire for bale tying. In the past baling has required much handling of the hay and handwork to tie the bales. Recent developments have brought to our farms the field pickup self-tying twine and wire balers which are sufficiently automatic in operation to permit one man with a tractor to bale three to five tons of hay per hour. The power mower and side delivery rake have been in use for some time. Recently, simple types of bale pickups have been developed so that now it can be said haymaking is near full mechanization with one-man machine operations. Loading and piling bales are not quite one-man operations and here may be a mechanica challenge to those interested in conveyer equipment.

[4] "The Mechanical Harvesting of Cotton," by H. B. Smith, B. T. Killough, M. H. Byron, D. Scoates, and D. L. Jones, Texas Agricultural Experiment Station, Bulletin No. 452, August, 1932.

[5] "Mechanization of the Cotton Harvest," by F. J. Welch and D. G. Miley, Mississippi Agricultural Experiment Station Bulletin No. 420. June, 1945.

[6] "Mechanical Production of Cotton," by P. W. Gull and J. E. Adams Mississippi State College, Bulletin No. 423, September, 1945.

Field-chopping of hay is a growing practice having labor-saving attractions, particularly where the hay is harvested for consumption on the ranch. It is not easily packaged and commercial haulers do not like to handle chopped hay in bulk, even when the material density approaches that of baled whole hay.

Mechanization of haying operations involves much more than gathering together high tonnage at a low expenditure of power and labor. Quality must be maintained to meet nutritional and marketing standards. The grading of unprocessed or whole hay is based primarily on color and leafiness, both requiring the timely handling of the crop. This must take place as soon after cutting as moisture conditions permit. This timeliness factor has tended to influence the development of single-operation equipment as mowers, side delivery rakes, and pickup balers. There is always risk in a chain series of machines which may have variable operating efficiencies since all series operations tend to contribute to lower over-all efficiencies when operated as a single unit. Thus we have at present the one-machine one-man standard for bulk and packaged whole-hay operations.

Where hay of high carotene content is required this involves cutting and immediate drying by artificial methods, and the subsequent processing of the dried product into meal. Since the hay is handled while green, machines in combination are more often used as mowers, side delivery rakes, and pickup choppers, which deliver the cut product to field trucks or barges for delivery to the drier. This cut hay is then dried usually in low-temperature tunnel-type driers or high-temperature rotary-kiln dehydrators, processed into meal through hammer mills, sometimes cooled, then bagged, and held in suitable storage awaiting favorable market conditions. These processes are largely mechanical and meal is produced having a carotene content much higher (10 times) than that of sun-dried bulk hay. The future trends in hay mechanization are likely to point more toward quality products than toward labor saving in materials handling. Processed hay has to be sold on the basis of chemical analysis in contrast to bulk grading which is based on texture, color, and leafiness.

FRUIT CROPS REQUIRE MUCH HAND LABOR

Fruit and nut crops are important in California's agriculture and in fact throughout the Pacific Coast region. Fruit crops particularly require much hand labor. For example, a 10-ton per acre crop of cling peaches requires 293 man-hours of hand labor, 69 per cent of which is used up in harvest operations. An acre of grapes producing 2 tons of raisins requires 154 man-hours, 59 per cent of which is required for harvesting. A 6-ton per acre crop of fresh apricots requires 235 man-hours of labor with 57 per cent of this used up in harvest work. A 6000-pound per acre cherry crop uses up 469 man-hours of labor with 88 per cent of this allotted to harvest work. This type of work is not easily mechanized because judgment is required to pick most soft fruits. The same applies to the thinning of fruit and the pruning of trees. All of these operations are in the tree and are performed from the ground or from ladders. No one as yet has been able to devise an acceptable mechanical man-labor aid to increase the efficiency of the man who must work in the tree. With modern hydraulic controls and lifts, such a device might be possible or even practical for crops like peaches, pears, apricots, oranges, and lemons. Mechanical tree shakers are now largely used for harvesting walnuts and prunes and to a lesser extent almonds. Mechanical pruning shears have been developed and offer some promise in labor saving. Wine grapes are now bulk-handled in some cases and field-crushing is being tried out. Some of our vegetables are being bulk-handled. Many of our fruits and vegetables are handled in field containers weighing around 60 pounds gross and with the millions of tons of products many more millions of field boxes are handled. The use of fork trucks and pallets is offering some promise in reducing hand labor for loading and unloading operations as well as lowering depreciation in containers. This part of fruit and vegetable production is a materials-handling problem which could be materially improved through the use of better-engineered equipment such as containers, hoists, and conveyers.

PESTS

Pests take a tremendous toll of farm crops each year. Farmers spend millions of dollars for herbicides, fungicides, and insecticides each year as well as other millions for man labor and equipment. Many types of mechanical applicators are in use ranging from knapsack sprayers to the airplane. From an engineering point of view pest-control machinery development is not very glamorous—it is a continuous headache. Pests are not eradicated, they are at best kept only under economic control. The use of chemicals toxic to these pests presents many hazards in application for workers, from residues on food crops, from drift to other crops, domestic animals, and beneficial insects, etc. Furthermore, pests have a tendency to develop tolerances for materials used for their control, so it becomes a constant battle to keep ahead of them. Many new chemicals are now available for pest-control work, but careful research is necessary before general use can be recommended.

Labor reduction is a key problem in this work also. Automatic sprayers are coming into use largely through necessity since hand-spraying operations are unpleasant and workers now have no difficulty in finding more pleasant tasks. These power-operated applicators do save much labor and they are really a great boon to orchardists during this period of farm-labor shortage. They leave something to be desired, however, in control of certain pests, and generally they are wasteful of materials. Dusting operations are more rapid and if they provide control are more economical than spraying. However, the tendency for dusts to drift long distances beyond the crop intended for protection, has caused much controversy among farmers and in some cases county ordinances have been passed to control their use. The use of chemicals for the control of soil pests such as nematodes is increasing and much of the success of this work depends on the development of equipment to properly inject the materials into the soil mass at reasonable cost.

Weed control other than by mechanical methods is growing in farm favor. Oil sprays have been used for a number of years for weed control by some citrus growers with savings in both power and labor. It is now used experimentally for pre-emergence weed-control work in row crops and for alfalfa. The quantities of Diesel oil used are relatively small, amounting to about 50 gallons per acre. Hydropneumatic pressure systems may be used for application purposes.

Flame cultivation is now being advocated for certain crops as a weed-control measure. Some plants like cotton are resistant to a flash flame, as from a blowtorch, while soft grasses and weeds will quickly sear to a point which will arrest their growth. Flame cultivation may be used for weeding bulb plants like onions and some success has been reported for weeding root crops like carrots. Flame cultivation as yet has not received farmer acceptance but it has some promising aspects.

With so many kinds of pests having varying life cycles and responsive to varying climatic environments, the mechanical equipment required is in a constant state of flux. A new chemical may promise a new method of attack, only to be abandoned some years later when the pest builds up an immunity to the once toxic material. A material, like an oil spray, may be

used with apparent satisfaction for a term of years and later come under suspicion because of loss in tree vigor or fruit quality. Soils may accumulate poisonous residues from continued use of arsenicals which may reach an alarming level and new materials must be sought. These factors have tended to interrupt long-time and much-needed research studies on the effect of particle size on carry of materials, coverage, penetration, and other basic factors involved. Needless to say not only engineering and entomological research, but the ingenuity of mankind must be enlisted in this continuous struggle between man and the pests which are ever-present to consume the fruits of his labor.

FARM POWER PLANT

Mechanization of agriculture is closely associated with the use and development of farm power. Human power which characterizes the agricultural operations of most of the famine-vulnerable countries of the world is inefficient and expensive. The use of power, other than human, has marked the outstanding agricultural progress of this nation as has also been the case in Russia in recent years. The animal-power period in American agriculture beginning about a century ago reached its height during World War I (1916), and has since declined at a rapid rate. This decline has had two direct influences on our agricultural development, (*a*) the release of land formerly required to produce food (fuel) for the animal power plant, and (*b*) the release of labor required to care for these animals. It is estimated[7] an adult work horse consumes the produce from 3.5 crop acres and 1.8 acres of pasture annually. Likewise, it requires about 50 man-hours of over-all maintenance work annually to care for an adult horse. These figures when applied to 10 million adult work horses no longer used on our farms because of tractors and trucks, represent many millions of crop acres now available for other uses and the release of approximately 500,000,000 man-hours of farm labor. Horses have largely disappeared from California farms as work animals, but are increasing in use somewhat for recreational purposes. There are approximately 2,100,000 tractors on the farms of this country, about one for every three farms. In California, we have approximately 70,000 farm tractors, or approximately one for every two farms. The tractors of this state are larger in drawbar horsepower than for the nation and the annual hours of use more than 50 per cent higher than the national average. The conclusion should not be reached from these data, however, that every second farm in California has a tractor. Nearly 60 per cent of the farms of this state range in size from three to fifty acres. Many of these do not support a tractor and on the other hand some of the larger farms have a fleet.

Tractor power is of course mobile power, and this type of power requirement is one of the peculiarities of the agricultural industry. On the farm the power plant is taken to the work in contrast to bringing the work to the power plant as is characteristic of most manufacturing plants. The power plant for the farm must be mounted on wheels or tracks. Generally speaking rubber-tired tractors predominate. In California both wheel and track types are used, the former representing about 60 per cent of the total number, and tracklayers 40 per cent. The latter, however, have a higher drawbar rating and generally are used 25 per cent more hours per year, so they actually perform about 55 per cent of the total drawbar work.

The trends in tractor development are toward both larger and smaller sizes. Diesels predominate in the larger- and medium-sized tracklayers and are coming into greater use for the larger wheel-type units. High-compression motors are being used on many of the newer gasoline-fueled wheel tractors. Built-in hydraulic control equipment is found on most new models and tooling bars are arranged for quick-detachable implements made up in parts which may be handled by one man. Most wheel tractors may be obtained in a number of models like row crop in both regular and high clearance, standard, and orchard models. Much interest has developed in new models of small tractors. One company (the International Harvester Company) has announced a four-wheel rubber-tired riding tractor, which in appearance, is similar to its larger models. This tractor will have 7 to 8 hp on the drawbar and it weighs 1050 pounds. It will have a line of farm tools for attachment to its frame and tooling bar so that it becomes a base power plant for the small operator. Other companies are contemplating similar small tractors designed for complete tooling and apparently engineered to meet the needs of the small farm, family-operated. These no doubt will be keen competitors in the so-called garden-tractor field for commercial operations, but the latter now being developed with better engineering features still have fine sales potentialities for close-quarter operations and subsistence-farm operations now becoming common in suburban developments.

The mobile power plant is the heart of mechanical farming. Other things being equal the power plant must be geared to the size of the farming operation. The larger the operation the easier it is to do this. Likewise, the larger the power unit one man can control with its implement attachments, the greater the economy of operation. The small tractor does not guarantee the owner an even competitive chance with the owner of a big tractor. It does, however, give him a better chance, and for family farm operations a reasonable promise of a satisfactory way of life. Operating economics on the farm are basically the same as in the factory. Only the conditions of operating environment are different. Mechanization of agriculture has greatly magnified the opportunities for farm management and machines are merely the tools for improved management. Likewise, when these machines are improperly selected, operated and maintained they become accelerators to failure.

Implement designers, of necessity, must try to meet the production trends in agriculture. They may be seeking a mass-production market when emphasis is placed on the smaller-sized tractors. Surely, mass production reduces manufacturing costs and there are in many sections of our country great numbers of small farms. In our own state 60 per cent of the total number of farms have less than 50 acres each. In fact over 45 per cent of our farms have less than 30 acres each. In the Old South and along the Atlantic Seaboard, small farms predominate. These offer sales attractions for tractor manufacturers. In California the incidence of tractors on farms of less than 10 acres is about 1 in 10; for farms of 10 to 29 acres, 1 in 3; and for farms of 30 to 49 acres, 2 in 5; while the incidence of tractors on farms of 225 to 260 acres is 1 per farm. This low ratio of tractors for small farms justifies the design thought that is now going into the smaller units.

In the larger units designers are devoting more attention to the implements going with the tractor, when using the tractor itself as the foundation unit. For example, the cotton picker is a tractor-mounted unit. Many of the modern corn pickers are tractor-mounted, as are forage choppers, combines, etc. These designs are pointed more toward the average-sized farms, while for large operations drawbar tools, self-propelled machines, and combination power take-off and auxiliary engine units are in demand.

Farmers, especially the larger operators, have learned how to capitalize farm machines. They recognize obsolescence particularly when labor rates are sharply advancing. This has

(*Continued on page 742*)

[7] "Changes in Farm Power and Equipment, Tractors, Trucks, and Automobiles," by E. G. McKibben and R. A. Griffen, Report A-9, W. P. A. National Research Project, App. D_1, D_2, D_3, 1938.

An Exploratory Excursion Into

GAS-TURBINE PATENTS

By ERNEST M. FERNALD

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As a personal project, the author started some months ago to read the U. S. patents relating to gas turbines. His activity in this regard became known to the Gas Turbine Coordinating Committee of this Society, and, since the state of the art is of some concern to engineers, the present brief paper based on patents was scheduled. The scope of the paper is restricted to patents relating to stationary and marine plants of the continuous-combustion type, aircraft power plants being excluded. Moreover, it deals only with patents issued between January, 1925, and July, 1945.

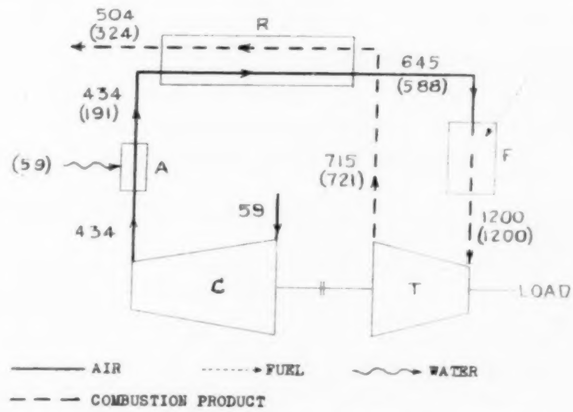
Certain patents of relatively few inventors and firms constitute the principal illustrative material, although passing reference is made to others. The paper offers samples of three types of discussion which arise very readily out of patents. These are (1) mention of relatively unpublicized ideas, (2) discussion of patented schemes from some particular point of view (the author's happens to be thermodynamic), and (3) digests of the patents themselves. Omitted, because of lack of competence on the part of the author, is any attempt at what might be expected from a patent attorney. Expressions of judgment are invited concerning the apparent value or lack of value of the several types of material presented.

SOME PATENTS CONCERNING OPEN-CYCLE PLANTS

One of the most prolific of inventors is the Swedish engineer Alf Lysholm, whose positive-displacement compressor is used in the 2500-hp plant that the Elliott Company built for the Navy. In the Navy's list of gas-turbine patents for the period 1925–1942, he is credited with 34 patents. Eleven of these, concerning systems suitable for stationary and marine use, are abstracted in Appendix 1. They are there arranged in apparent order of conception, rather than according to date of issue in the United States. The selection of Mr. Lysholm's patents for the section of this paper concerning open-cycle plants has no particular significance. Others would have done as well.

Throughout his patents Lysholm indicates that he favors radial-flow turbines and injection of water into the stream of motive fluid. His partiality for radial-flow turbines may well have come about through his connection with a Swedish firm that promotes them. He discusses their qualities rather extensively in some of his patent specifications. With respect to injection of water, Lysholm points out that whereas injection into the combustion chamber results in greater capacity but lower efficiency, injection of water into the compressed air ahead of a regenerator yields greater capacity with high efficiency.

Fig. 1 illustrates what happens to temperatures when approximately 5 per cent of water is injected between the compressor *C* and the regenerator *R* at point *A*. The resulting temperatures are shown in parentheses in comparison with those



5% of water yields temperatures in parentheses (approx).

Water is injected at A.

FIG. 1 EFFECT OF WATER INJECTION ON TEMPERATURES

obtaining without injection of water. The lower temperature of the compressed air entering the regenerator (191 F versus 434 F) permits more heat to be reclaimed from the turbine exhaust, with corresponding reduction in temperature of exit gas to 324 F, from 504 F without water injection. Assumptions used in connection with Fig. 1 were as follows: Pressure ratio, 5; compressor efficiency, 80 per cent; turbine efficiency, 85 per cent; regenerator effectiveness, 75 per cent; constant specific heat; and total neglect of pressure and radiation losses and of increase in mass of motive fluid due to the fuel added to it.

Without injection of water the thermal efficiency was approximately 24 per cent. With injection of water in amount sufficient to constitute about 5 per cent of the motive fluid, capacity per pound of motive fluid was increased 27 per cent. If the water was injected between the compressor and the regenerator, the efficiency of the plant rose from the mentioned 24 to 26 per cent, but if an equal quantity was injected instead into the combustion chamber, the efficiency dropped to 20 per cent. Lysholm's patent No. 2,115,338 (April, 1938) covers plants in which water is injected between the compressor and the regenerator. However, injection of water into the air at the start of compression, with resulting wet compression, seems to offer still greater thermodynamic advantage.

In 1937 Lysholm was granted U. S. Patent No. 2,091,998 covering gas-turbine systems using a regenerative heater for recovery of heat from the exhaust of the low-pressure turbines. All his claims specify that the quantity of heat so recovered shall be at least the equivalent of the work done by the turbines exhausting directly into the regenerator. Fig. 2 shows the arrangement of plant illustrated in his patent. Since a regenerator is used in all but the simplest of current designs, one is naturally interested in whether rights must be obtained

Presented at the National Meeting of the Oil and Gas Power Division, Milwaukee, Wis., June 12–15, 1946, and at the Semi-Annual Meeting, Detroit, Mich., June 17–20, 1946, of The American Society of Mechanical Engineers.

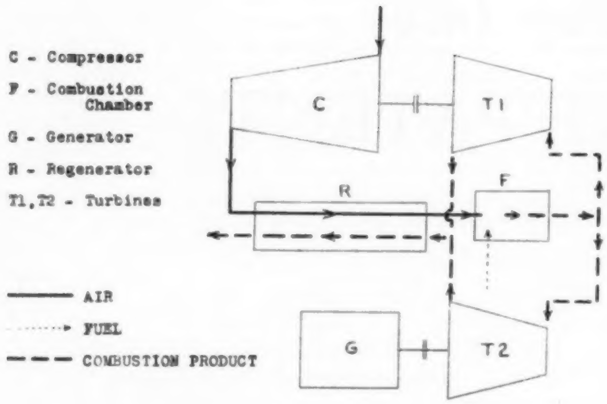


FIG. 2 PLANT HAVING REGENERATOR

(Lysholm Patent 2,091,998—September 7, 1937.)

under this patent. Perhaps someone will tell us about it in the course of the discussion.

Other ideas of Lysholm can be gathered from the patent digests in Appendix 1. Critical comment on these digests is invited and also on the very brief ones given in Appendix 2. There appears to be appreciable demand for digests, and it would be just as well if any coming out under committee auspices should set a good example. Lysholm patents not summarized in Appendix 1 deal with aircraft power plants, details of turbine design, and so on. Only those covering complete systems suitable for stationary or marine use were selected for mention in this paper.

In connection with Mr. Lysholm's work, we might consider briefly one thermodynamic aspect of his pet water-injection scheme, since very few words are required to point out the salient features of the situation with respect to plant capacity. Referring again to the example in which injection of 5 per cent of water increased capacity 27 per cent, it is noteworthy that the increase in capacity per pound of motive fluid is due in part to the greater available energy for steam over that for air. For expansion from 5 atm and 1200 F to 1 atm, the available energy or maximum theoretical work is 248 Btu per lb for pure steam but only 150 Btu per lb for pure air. Hence the more steam present, the greater the turbine output per pound of motive fluid. At the same time, compressor input is decreased per pound of final motive fluid, because the work of compression for the water injected is only about 1/400th of that required for an equal mass of air, compression efficiency in each case being reckoned at 80 per cent. Hence injection of water results both in greater gross turbine output and less "back work," with substantial percentage increase in the net work which is their difference. The disparity between the work of compression for water and that for air illustrates the great advantage in compressing a substance in its liquid phase, where its volume is small.

CLOSED-CYCLE PLANTS

The author has little to say on patents relating to plants operating on a fully closed cycle. The Navy's 1925–1942 list of patents does not include any pertaining to such plants. Indeed, the list of patent classifications that the Navy searched does not include Classification 60-59, in which all closed-cycle patents appear to be concentrated. The author has not searched 60-59, although he has a few patents therefrom.

The only comment offered is that Escher-Wyss, promoter of the closed-cycle scheme, appears to report developments rather promptly, releases in the "Escher-Wyss News" and elsewhere sometimes running ahead of issuance of the corresponding U. S. patents. For example, Dr. Keller's paper before the 1945 Annual Meeting illustrates a control scheme whose U. S. patent seems not to have been issued as yet. The time between the application for and the granting of a U. S. patent, by the way, may be as much as 4 years, or even more. In the meantime, a foreign patent covering the invention will likely have appeared.

MODIFIED CLOSED CYCLES

Plants designed to operate on modified closed cycles are covered by patents controlled by Westinghouse and by Sulzer Brothers of Switzerland. In both schemes working fluid is continuously withdrawn from the system and fresh air concurrently added. The difference between them is that Westinghouse mixes the product of combustion with the main recirculated stream whereas Sulzer does not. Sulzer uses a surface-type heater to supply heat to the recirculated motive fluid, which is pure air. The Westinghouse scheme was widely publicized in the American technical press in 1944. Up to the time of writing, this particular Sulzer scheme had received no publicity whatsoever in the technical press, although that embodying a free-piston generator had been described.

Fig. 3 shows the Westinghouse scheme in diagram. As indicated, the main circuit comprises essentially a compressor *C1*, a regenerator *R*, a turbine *T1*, and a cooler *K*. Auxiliary to this circuit is a compressor *C2* for make-up air, driven by a turbine *T2* supplied with motive fluid drawn from the high-pressure side of the system at *A*. Both the auxiliary turbine and the auxiliary compressor operate between the high-pressure side of the system and the atmosphere. According to the patent, the fuel is burned in the stream of fresh air continuously taken into the system. Mixture of this new combustion product at *B* with the recirculated stream, composed of product of earlier combus-

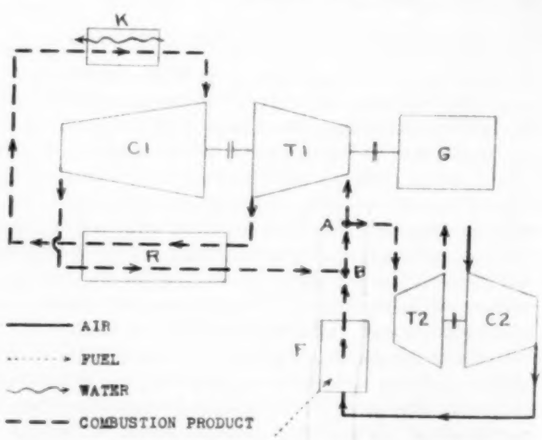


FIG. 3 WESTINGHOUSE MODIFIED CLOSED CYCLE

(W. R. New Patent 2,303,381, December 1, 1942.)

tion, heats the motive fluid as required. The heated motive fluid divides as indicated at *A* so as to serve both main and auxiliary turbines. The density of the motive fluid can be altered to suit the load through change in the speed of the auxiliary turbine. No indication of control devices appears in either the original patent or in the technical articles.

Fig. 4 shows in diagram a simple plant embodying the Sulzer modified closed cycle. The first U. S. patent relating to this scheme was issued to Walter Traupel in December, 1941. The essential feature is a division of the air stream as indicated at *A*. Some of the air goes to the combustion chamber of the closed heater *F*, the rest recirculates. The product of combustion,

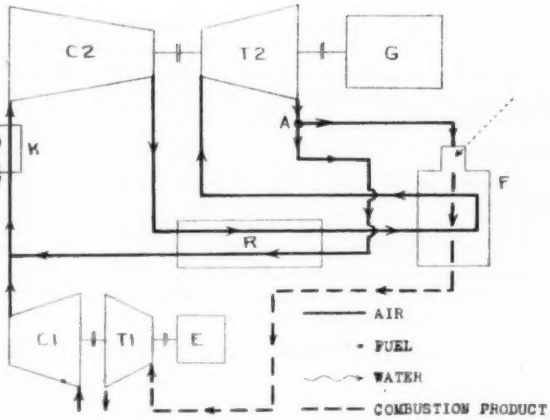


FIG. 4 SULZER BROS. MODIFIED CLOSED CYCLE
(Traupel Patents, 1941+.)

after heating the main stream of pure air in the closed heater, expands to atmosphere in the turbine *T*1. This turbine drives the make-up compressor *C*1 and the electrical machine *E*, which may run as either a generator or a motor to balance the output. In this type of plant, as in the Westinghouse, the density of fluid in the main circuit may be varied to suit the load, thus promising good part-load efficiency. Subsequent patents concern details of arrangement and connections, some showing division of the air stream on the high-pressure side of the system, and the "auxiliary" turbine driving the load.

All gas-turbine systems might well be scrutinized with respect to use of coal as fuel. The Westinghouse system is as disadvantageous as any in that respect, as the motive fluid for all its turbines must be freed of troublesome ash. Sulzer avoids the ash problem in the main circuit, but has it in the auxiliary turbine. Westinghouse avoids the expensive and perhaps troublesome air heater which Sulzer must contend with. Thus both firms have difficult problems to solve.

COMBINED GAS-TURBINE AND REFRIGERATION PLANT

A decidedly out-of-the-ordinary scheme is proposed in U. S. Patent No. 2,322,717, issued in June, 1943, to Frederick Nettel. In brief, the idea is to couple together a gas-turbine plant and an absorption refrigeration plant so that the exhaust heat from the turbine is utilized in precooling the air to be compressed. Since cold air requires less work to compress it than does warm air, one result should be greater net output for the plant. Also, efficiency should be somewhat greater than that of a simple plant without a regenerator.

Detailed thermodynamic analysis of the ultimate possibilities of such a system might be interesting to some, but would take us too far afield. However, one item might be mentioned, the amazing amount of precooling theoretically possible; Fig. 5 indicates this. At the left, to temperature-entropy coordinates, are shown the compression *A-B*, the heating *B-C*, and the expansion *C-D*, that would obtain in a simple ideal plant comprising a compressor, a combustion chamber, and a turbine. The total amount of heat obtainable from the exhaust, by cooling it from 589 to 59 F, the atmospheric temperature, is represented by the total area under *D-A*. The portion of this heat theoretically realizable as work is represented by the vertically hatched portion of this area, that is, the part lying above the horizontal line denoting atmospheric temperature. Now, the maximum refrigeration effect from the exhaust heat cannot exceed the refrigeration obtainable by using this theoretically available work to drive ideal refrigeration apparatus. Such use of the exhaust heat would in the present instance, and as the theoretical limit, permit precooling the air entering the compressor to —253 F, the cooling process being denoted by *A-F*. The vertically hatched areas below *D-A* and above *A-F* are equal; thermodynamicists will connect them with two series of infinitesimal Carnot cycles, but that is another story. It is intended merely to point out that there really is a considerable refrigeration effect to shoot at. The rest of Fig. 5 is immaterial to this discussion.

CONCLUSION

In conclusion, the author points out that samples of two out of three types of material mentioned at the outset have been presented; that is to say, mention has been made of hitherto unpublicized gas-turbine systems and several ideas have been examined against a thermodynamic background. The third type of material, patent digests, is not suited to oral presentation, but appears in the Appendixes.

We should consider carefully how patent digests figure, or could figure, in our general scheme of things. Also, it is hoped

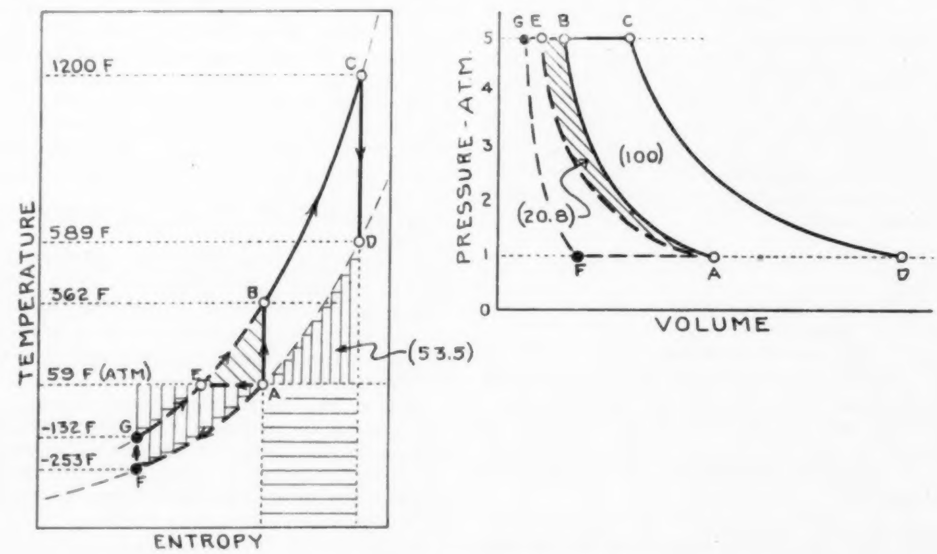


FIG. 5 IDEAL GAS-TURBINE CYCLES

that we shall exchange information on what we all do about the patent literature, as it is often called. Its relative importance is doubtless not the same in all lines of work. A leading research chemist has indicated to the author that he gets about 70 per cent of his knowledge of progress in his field from the patent literature. It is understood that U. S. chemical patents are covered in "Chemical Abstracts," and foreign patents in a publication known to chemists as the "Zentralblatt." No such systematic coverage obtains for mechanical engineering.

The general form of patent digest suitable in our field might well be considered and discussed. The "*Patent Office Gazette*" publishes one diagram and one verbatim claim for each patent issued. This much enables anyone to decide whether he wants to get the patent itself and read it. Two sets of digests are appended to this paper: Those in Appendix 1 are not especially condensed, those in Appendix 2 are very much so, being made in accordance with a suggestion by a member of the Coordinating Committee for digests in one sentence. Undoubtedly private firms make digests for their own use. Samples of what has proved to be practical would be very welcome in the discussion.

There appear to be two basic questions:

1 What is the place of the patent literature in American engineering?

2 Can this Society, or various subdivisions thereof, appropriately carry on anything useful concerning it?

Appendix 1

SAMPLE DIGESTS OF U. S. PATENTS

The patents are arranged in apparent order of conception. The USN numbers relate to the Navy's list of gas-turbine patents, 1925–1942. The earliest date of record is indicated as well as the date of issue. All these patents concern continuous-combustion open-cycle plants.

"Gas Turbine System" (USN 84), to Alf Lysholm
1,988,456 (22 January, 1935)
App. 523,767 (19 March, 1931): Ger. app. 24 March, 1930
3 p, 2 ill., 6 claims: Class. 60-42
Assigned to Aktiebolaget Milo, Stockholm, Sweden

Formation of motive fluid for plants in which provision of sufficient compressor capacity to afford large excess of air at all loads would not be economical (example, peak-load plants).

Ordinary fuel is burned with ordinary amount of excess air for loads up to those at which soot would form. For heavier loads, the ordinary fuel is supplemented by nonsooting fuel; alcohol, for example. Injection of water is favored to minimize sooting from ordinary fuel and to keep temperature down after the nonsooting fuel is supplied. Temperature may also be kept down through incomplete combustion of the nonsooting fuel. For the peak-load plants contemplated, high thermal efficiency is not of prime consequence.

"Gas Turbine System" (USN 83), to Alf Lysholm
2,078,956 (4 May, 1937)
App. 715,267 (13 March, 1934): Ger. app. 24 March, 1930
8 p, 4 ill., 6 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

According to the specification, the state of the art was such at the time of application that the constant-pressure gas turbine has been "relegated to the background as wholly impractical in favor of the more complicated explosion type of apparatus." The invention purports to be a type of continuous-combustion (constant pressure) plant that will work satisfactorily.

The plants illustrated include compressors and a generator load driven by separate turbines, those shown being radial-flow, double-rotation, reaction turbines. Compressors are connected in series, turbines in either series or parallel. Intercooling is indicated, but not regenerative heating. Injection of water into the combustion chamber is shown in one variant. The plants illustrated are regulated through control of the fuel in response to change in speed of the load turbine. Parallel connection of the turbines is stated to be better for variable load, series connection for constant load.

Items common to all 6 claims are:

1 Reaction blading having a thermodynamic efficiency of at least 80 per cent.

2 In the turbines, a path for the motive fluid having a substantial component in a radially outward direction.

3 Full admission of motive fluid to the blading.

4 The temperature of the motive fluid at the beginning of the expansion to be 800 C absolute (980 F) or over.

Four claims specify also "conduits arranged for free and continuous flow."

"Gas Turbine Apparatus" (USN 82), to Alf Lysholm
2,078,957 (4 May, 1937)
App. 681,697 (22 July, 1933): Ger. app. 24 March, 1930
6 p, 3 ill., 6 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

The object of the invention is to provide improved apparatus. A typical plant covered by the patent would have the following features:

1 Two reaction turbines operating independently of each other with respect to speed and connected in series with respect to motive fluid.

(*a*) The flow through each to have a substantial component directed radially outward.

(*b*) Full admission over the inlet to the blading.

(*c*) One turbine delivering power externally, the other driving a compressor.

2 Separate combustion chambers for initial heating and reheating of the motive fluid.

3 Conduits of substantial length connecting each combustion chamber with the succeeding turbine.

4 Temperature of the motive fluid at the beginning of expansion to be 800 C absolute (980 F) or over.

All of the foregoing appear in each claim.

"Gas Turbine System" (USN 81), to Alf Lysholm
2,078,958 (4 May, 1937)
App. 51,230 (23 November, 1935), a continuation of 522,923 (16 March, 1931): Ger. app. 24 March, 1930
10 p, 3 ill., 15 claims: Class. 60-42
Assigned to Aktiebolaget Milo, Stockholm, Sweden

The object is to provide a plant yielding good efficiency at all loads and yet simple to regulate. The invention covers plants including at least two turbines independent of each other with respect to speed. One turbine drives the load. Another must drive the compressor furnishing the lowest stage of compression, and in addition must exhaust at approximately constant back pressure (atmospheric). All conduits are open and unthrottled. The plants are regulated through the fuel supply, with or without injection of water. Extensive discussion supports the thesis of good regulation without throttling of motive fluid.

"Gas Turbine System for Varying Load" (USN 85), to Alf Lysholm
1,959,785 (22 May, 1934)
App. 638,908 (21 October, 1932): Ger. app. 24 October, 1931
6 p, 4 ill., 19 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

A principal object is to provide a plant that will operate with high efficiency over wide ranges of load and speed, with particular reference to the propulsion of ships.

The invention consists in the provision of compressors that can be put into operation by engagement of releasable couplings, so as to afford, through additional stages of compression, higher pressures at heavy loads. The last compressor so engaged becomes the low-pressure stage, taking air from the atmosphere and delivering it to the compressor next in line.

"Gas Turbine System" (USN 77), to Alf Lysholm
2,115,338 (26 April, 1938)

App. 702,014 (12 December, 1933): Br. app. 15 December, 1932
7 p, 6 ill., 24 claims: Class. 60-42
Assigned to Aktiebolaget Milo, Stockholm, Sweden

In the interest of thermal efficiency, the air is cooled after compression, preferably by injection of water, in order to increase its ability to recover heat from the turbine exhaust in a regenerator.

In some variants, the injection water is preheated in a heat exchanger through which the turbine exhaust passes after it leaves the regenerator. In others, the compressed air is cooled by water in a surface-type cooler so as to convert the cooling water into steam, which is expanded in a separate steam turbine.

"Gas Turbine System" (USN 78), to Alf Lysholm
2,115,112 (26 April, 1938)
App. 707,499 (20 January, 1934): Ger. app. 1 February, 1933
6 p, 3 ill., 14 claims: Class. 60-42
Assigned to Aktiebolaget Milo, Stockholm, Sweden

Plants designed especially for satisfactory operation at part load and having two essential elements. One element includes a turbine driving both a useful load and a compressor, fuel being burned in the compressed air. The other essential element comprises a second turbine driving only a compressor. At light loads, only the first element is used. At heavier loads, the second is cut in. The motive fluid then passes through both turbines in series. The compressors may be connected in series or in parallel, to suit the load.

"Gas Turbine System of the Continuous Combustion Type" (USN 79), to Alf Lysholm
2,095,991 (19 October, 1937)
App. 749,006 (19 October, 1934): Br. app. 8 March, 1933
11 p, 19 ill., 14 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden.

The specification points out that when a plant is regulated solely through the main fuel supply the exhaust temperature for any turbine operating against substantially constant back pressure (atmosphere) is likely to rise higher than is good for the exhaust blading; especially for the exhaust blading of radial-flow turbines, which is at the same time the longest and by far the most highly stressed through centrifugal force. The invention aims to overcome the undesirable characteristic mentioned, in plants having a power turbine and a compressor turbine operating independently of each other with respect to speed.

For such plants, the invention provides secondary governing means whose effect is to limit the temperature of the motive fluid exhausted from turbines operating at constant back pressure. Methods illustrated embody the following procedures at part load:

1 Throttling the supply of motive fluid to the power turbine.
2 Increasing the temperature of the motive fluid supplied to the compressor turbine, through use of an auxiliary combustion chamber.
3 Decreasing the temperature of motive fluid supplied to the power turbine, through use of a by-pass line leading air directly to it from the compressor.
4 Injection of water into the compressed air in or before the main combustion chamber.
5 Combinations of the foregoing.

The effect of any of these procedures is to increase the volume of motive fluid over that obtaining for the same plant load under simple control of the main fuel supply. Under procedures 1 to 3 pressure is also higher. Available energy and fuel supply are asserted to adjust themselves so that the exhaust temperatures mentioned do not exceed permissible values.

"Gas Turbine System of the Continuous Combustion Type" (USN 76), to Alf Lysholm
2,131,781 (4 October, 1938)
App. 2457 (19 January, 1935): Ger. app. 20 January, 1934
4 p, 2 ill., 10 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

Covers plants having a radial-flow double-rotation turbine and an axial-flow turbine operating independently with respect to speed and in parallel with respect to motive fluid. The radial-flow turbine receives motive fluid at higher temperature than does the axial-flow turbine. The radial-flow turbine drives the compressor, which is in two sections operable at different speeds; the axial-flow turbine drives the load.

The higher temperature of motive fluid for the radial-flow turbine is obtained either by supplementary heating in a second combustion chamber of the portion of the motive fluid headed for that turbine or, alternatively, by mixing unheated compressed air with the motive fluid headed for the axial-flow turbine. Radial-flow turbines are alleged to withstand higher initial temperatures than axial-flow, 1070 F being stated to be higher than the latter can stand.

"Gas Turbine System" (USN 80), to Alf Lysholm
2,091,998 (7 September, 1937)
App. 7693 (23 February, 1935): Ger. app. 24 March, 1934
7 p, 8 ill., 12 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

According to the specification, the state of the art at the time of application was such that continuous-combustion gas-turbine power plants embodying radial-flow turbines operating up to 1300 F and over were recognized as practicable, but that axial-flow turbines were not considered to be operable at temperatures high enough to yield satisfactory thermal efficiency for the plant. The invention aims to obviate this drawback by reclaiming heat from the exhaust of axial-flow turbines operating at 1000 F or so.

The invention consists in provision of a regenerative heater in which the compressed air is heated by the exhaust from axial-flow turbines in which the expansion through the lowest part of the pressure range takes place. All the claims specify that the quantity of heat reclaimed in the regenerator shall be at least equivalent to the work done by the turbine(s) exhausting into it.

"Gas Turbine System" (USN 74), to Alf Lysholm
2,225,311 (17 December, 1940)
App. 179,236 (11 December, 1937): Ger. app. 15 December, 1936
3 p, 1 ill., 5 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

Relates especially to plants in which the fuel is producer gas. The invention concerns plants having multiple-stage expansion with reheat between stages, the several combustion chambers being supplied with fuel gas generated at a single source, especially a gas producer burning solid fuel. The proportion of fuel gas devoted to reheating may be made smaller at light loads. The only streams throttled at part load are relatively small ones, the air supplied to the gas producer and the fuel gas devoted to reheating.

"Gas Turbine System" (USN 75), to Lindhagen and Lysholm 2,225,310 (17 December, 1940)
App. 179,926 (15 December, 1937): Ger. app. 16 December, 1936
4 p, 2 ill., 7 claims: Class. 60-41
Assigned to Aktiebolaget Milo, Stockholm, Sweden

Relates to plants having multiple-stage expansion with reheat between stages, the invention being that all the fuel is burned in compressed air at one place and a part of the combustion product used in surface-type heat exchanger(s) for reheating, the product so used thereafter joining the motive fluid supplied to the high-pressure turbine. The quantity of gas used for reheating may be decreased or eliminated as the load on the system decreases.

"Gas Turbine Plant" (USN 73), to Alf Lysholm
2,238,905 (22 April, 1941)
App. 207,457 (12 May, 1938): Br. app. 14 May, 1937
7 p, 4 ill., 21 claims: Class. 60-41
Assigned to Marble, Merrill, and Batten, Trustees
Reissued 13 October, 1942, as Re 22, 201 (USN 71)

The several objects of the invention are to provide, in plants in which a single control would not be sufficient, simple controlling means easily adapted to varying load conditions, to provide for independent supply of heat to each of the various heating means and, further, to avoid as far as possible the use of valves for controlling the motive fluid. Illustrated are multistage plants with reheat, in which each combustion chamber is served by a separate fuel pump or gas producer. In all, fuel may be cut off relatively more in the later stages of reheat when load is decreased.

Appendix 2

CONDENSED DIGESTS OF PATENTS TREATED IN APPENDIX 1

The patents are arranged in order of issue.

1,959,795 (22 May, 1934), Alf Lysholm
"Gas Turbine System for Varying Load" (60-41)

Compressors are engaged and disengaged to suit the load.

1,988,456 (22 January, 1935), Alf Lysholm
"Gas Turbine System" (60-42)

Ordinary fuel is supplemented by nonsooting fuel at heavy load.

2,078,956 (4 May, 1937), Alf Lysholm
"Gas Turbine System" (60-41)

Compressor(s) and generator are driven by separate turbines, which are full-admission reaction turbines having blade efficiency of 80 per cent or more, substantially radial flow, and inlet temperature of 980 F or over.

2,078,957 (4 May, 1937), Alf Lysholm
"Gas Turbine Apparatus" (60-41)

Turbines connected in series on separate shafts drive the compressor(s) and the external load; separate combustion chambers serve for initial heating and reheating.

2,078,958 (4 May, 1937), Alf Lysholm
"Gas Turbine System" (60-42)

Turbines on separate shafts drive the compressor(s) and the load, the turbine driving the low-pressure compressor exhausting at approximately constant back pressure (atmosphere); the plant is regulated solely by throttling of the fuel.

2,095,998 (7 September, 1937), Alf Lysholm
"Gas Turbine System" (60-41)

Heat from low-pressure exhaust is transferred to the compressed air in a regenerative heater.

2,095,991 (19 October, 1937), Alf Lysholm
"Gas Turbine System of the Continuous-Combustion Type" (60-41)

To supplement governing by throttling of fuel, provision is made for any or all of (*a*) throttling the supply of motive fluid to the power turbine, (*b*) an auxiliary combustion chamber to increase the temperature of the motive fluid for the compressor turbine, (*c*) a by-pass line leading unheated air to the power turbine in order to decrease the temperature of its motive fluid.

2,115,112 (26 April, 1938), Alf Lysholm
"Gas Turbine System" (60-42)

Provides a supplementary turbine driving only a compressor, the combination being operated only at heavy load.

2,115,338 (26 April, 1938), Alf Lysholm
"Gas Turbine System" (60-42)

Provides for cooling the compressed air, as through injection of water, ahead of the regenerator in order to recover more heat from the turbine exhaust.

2,131,781 (4 October, 1938), Alf Lysholm
"Gas Turbine System of the Continuous Combustion Type" (60-41)

Radial-flow and axial-flow turbines are both used, the radial-flow turbines receiving motive fluid at the higher temperature.

2,225,310 (17 December, 1940), Lindhagen and Lysholm
"Gas Turbine System" (60-41)

Reheat scheme in which all the fuel is burned at one place and a part of the combustion product is used in surface-type reheaters.

2,225,311 (17 December, 1940), Alf Lysholm
"Gas Turbine System" (60-41)

Reheat scheme for producer gas in which the fuel gas is produced at a single source.

2,238,905 (22 April, 1941), Alf Lysholm
"Gas Turbine Plant" (60-41)

Reissued 13 October, 1942 as Re 22,201

Reheat scheme with independent supply of heat to each heating means.

Appendix 3

ADDITIONAL REFERENCES (TO JULY 1945)

General. "The United States Patents of Gas Turbine Plants (1925-1942)," Research Section, Bureau of Ships, Navy Department, April, 1943.

Closed Cycles (Escher-Wyss):

U. S. Patent No. 2,172,910
"Power Plant," Curt Keller, 12 September, 1939

U. S. Patent No. 2,203,731
"Means for Regulating and Starting Thermal Power Plants," Curt Keller, 11 June, 1940

U. S. Patent No. 2,268,074
"Protective Means for the Heaters of Thermal Circuits," Curt Keller, 30 December, 1941

U. S. Patent 2,319,995
"Overload Working Method for Thermal Power Plants," Curt Keller, 25 May, 1943

U. S. Patent No. 2,345,950
"Thermal Power Plant," Fritz Salzmann, 4 April, 1944

Modified Closed Cycles (Sulzer):

U. S. Patent No. 2,268,270
"Gas Turbine Plant," Walter Traupel, 30 December, 1941

U. S. Patent No. 2,298,663
"Gas Turbine Plant," Walter Traupel, 13 October, 1942

U. S. Patent No. 2,341,490
"Gas Turbine Plant," Walter Traupel, 8 February, 1944

U. S. Patent No. 2,361,887
"Gas Turbine Plant," Walter Traupel, 31 October, 1944

U. S. Patent No. 2,374,510
"Gas Turbine Plant," Walter Traupel, 24 April, 1945

Modified Closed Cycle (Westinghouse):

U. S. Patent No. 2,303,381
"Gas Turbine Power Plant and Method," Winston R. New, 1 December, 1942

Combined Gas-Turbine and Refrigeration Plant:

U. S. Patent No. 2,322,717
"Apparatus for Combustion Turbines," F. Nettel, 22 June, 1943

U. S. Patent No. 2,339,185
"Combustion Turbine," F. Nettel, 11 January, 1944

U. S. Patent No. 2,362,714
"Starting Combustion Turbines," F. Nettel, 14 November, 1944

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Science and Religion

MAN'S "creed of self-sufficiency" versus the source of all power—the "perilous gift" of atomic energy—is discussed in an article entitled "Science and Religion," by Rev. John Sutherland Bonnell, D.D., Fifth Avenue Presbyterian Church, New York, N. Y., appearing in the June, 1946, issue of *Think*. The article follows:

In England during the fall of 1927, nearly twenty years ago, I heard Sir Oliver Lodge, a notable British scientist, deliver a lecture. He said: "The time is coming when science will be able to split the atom. Incalculable forces will be made available. From a lump of matter that a man can hold in his hand there will be released more energy than can be produced today by all the coal mines of Britain." Then he added solemnly: "Please God, the discovery will not be made in our time, because we are not ready for it."

Well, for good or ill the discovery has been made in our time. This perilous gift has been thrust into the hands of man. Where shall we look for help? Shall we turn to the scientists? Science is the god of a great many people today.

This cannot be wondered at when one looks at the record of scientific progress since the beginning of this century. So much scientific development has taken place so many discoveries made that there is little wonder that for many people science is synonymous with knowledge, and that for some, science has become a divinity to which they give a blind unquestioning allegiance. As a matter of fact there is as much mystery in science as there is in religion, and there is also wide scope for faith. Always the scientist has had to employ a vivid imagination. The electronic theory was based on imagination and a fevered hope that it might work. It did, and we have been precipitated into the Atomic Age, the direct result of the first imaginative theory of the electron.

If you should go to any physicist and ask him: "Tell me, what is the subject matter of physics?" he would reply promptly, "Why, it deals with matter or substance in three forms—solids, liquids, and gases." You answer: "That is very interesting. Would you mind telling me just what matter is?" "I am sorry," the physicist would say, "but I do not know." "You are a physicist and you do not know what matter is?" "That is true. We talk about molecules and atoms as the bricks out of which matter is built, but the discovery of x rays and radium and the deadly power of Uranium 235 have shattered all our theories. All we can do now is to speak of matter as an electrical phenomenon."

In the light of this, how foolish for anyone to suggest that science is a substitute for religion! If someone objects that belief in God leads us into the realm of mystery, we frankly admit the truth of the assertion. It does, but where in all the universe will mystery not be found? Jesus has shown us how we can enter into fellowship with God by means of prayer; that even as the scientist taps enormous physical resources, so, by means of prayer, spiritual resources will flow into our lives, lifting them above fear, anxiety, and failure.

The scientists have just told us that they accept no responsibility for what man chooses to do with the power that is placed in his hands. "That is not our responsibility," they say. Will man then become his own destroyer? Will some angel, flying through the vault of heaven, look down upon the blackened cinder that was our earth and say: "Here once dwelt a race of men and women, made in the image of God, but they rebelled against His divine law, and used the forces given them for their own extinction."

If science, which has presented us with this dread power, cannot help us where shall we turn? Well, one of the scientists has given us the answer. Prof. Julian Huxley, the grandson of the great agnostic of the last century says: "Science is morally neutral; science has no scale of values. Only religion can help; only religion has a scale of values; only religion can exert that moral restraint upon the minds and hearts of men which may save the race."

Should this come to pass, then these mighty energies will be harnessed for the healing and the blessing of the world. The scientists of the leading nations will come together, not to release some pitiless destructive force, but to find, once and for all, a way to bring an end to tuberculosis and cancer, and infantile paralysis, and poverty and illiteracy, and all those dark evils that wreck human happiness. Then at last there shall emerge a world that is a fit dwelling place for God's children.

We must come back, as always, to the Bible, "Thou hast made him to have dominion over the works of Thy hand; Thou has put all things under his feet."

The Bible reminds us that all the power man possesses is derived from his Creator. When man steps forth with his creed of self-sufficiency and independence of Almighty God, his destruction and disintegration begin.

Atomic Energy

THE June, 1946, issue of *The Betz Indicator* contains the following interesting statement made by Dr. Reuben G. Gustavson, vice-president and dean of faculties of the University of Chicago, when he addressed a recent conference of the American Bankers Association, and serves to emphasize the tremendous force of atomic energy when used for destructive purposes:

The relationship between the destruction of matter and the liberation of energy was worked out by Albert Einstein in 1905. At that time he showed that the energy liberated would be equal to the weight of the matter destroyed multiplied by the square of the velocity of light. Now, light travels at a velocity of 186,000 miles per second and when you square that, you get 35,000,000,000 in round figures. Therefore, when you multiply even a relatively small amount of matter destroyed by 35,000,000,000 you come out with a gigantic figure.

The actual explosive material of one atomic bomb is something like the size of a tennis ball, with the actual destructive power equivalent to 20,000 tons of TNT—that is 400 freight carloads. Perhaps one way to make it clear would be to look at

it this way. During something like 5 years of war in Europe the Air Forces dropped approximately 1,000,000 tons of TNT. If that had been done with 10-ton blockbusters it would have required a minimum of 100,000 missions over a period of 5 years. The equivalent of that in explosive power is 50 atomic bombs, which could easily be dropped in the course of a half hour. This means that with the discovery of the atomic bomb it has been made possible to telescope 5 years of destructive air warfare into a matter of minutes.

Is there any question remaining in the minds of the average citizen of the need for a strong and lasting peace? Now that the fighting is over we must all realize that a peace among nations must be drawn up that is not only a lasting peace but one that would prevent future wars. For with a destructive force such as this existing on the face of the earth, few would be left remaining after another war to attend a peace conference. While it is true that the secret of the atomic bomb is in the possession of but a few governments, one must not forget that other countries have scientists who could, in time, discover its present secret.

When he spoke of peacetime or commercial aspects of atomic energy and what the atomic pile looks like, Dr. Gustavson said that these atomic-energy plants are spooky things. You see before you a giant block of cement maybe 12 feet on a side. In the interior of that is uranium embedded in graphite or in heavy water. The reaction is taking place. Energy is being liberated. You can have any temperature you want from a few hundred to a few thousand degrees—yet you can control it. Obviously, if you can liberate heat, you can boil water, turn a steam turbine, and generate electrical energy.

Ball Bushing for Linear Motion

AN antifriction ball bushing for linear motions has been developed by Thomson Industries, Inc., Long Island City, New York, thus bringing to the designer a bearing for linear movement that possesses the advantages and economies that ball bearings impart to rotary motion.

In addition to the reduction of wear, friction, and maintenance afforded by all types of antifriction bearings, the availability of ball bushings offers the engineer a solution to two troublesome problems inherent to plain sliding linear bearings. These are: (1) The oil film, over the exposed surface of the shaft upon which the plain bearing's operation depends, deteriorates due to oxidation and becomes gummy and grit-laden; and (2) plain linear bearings require a large length-to-diameter ratio to prevent cocking and binding. Free-rolling ball bushings sharply reduce this dimension requirement and permit startling design economies. The size, weight, and cost of countless mechanisms can be reduced by the use of this new-type bushing.

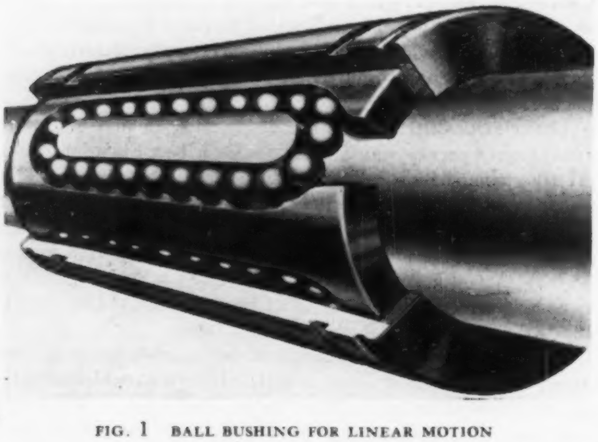


FIG. 1 BALL BUSHING FOR LINEAR MOTION

Ball bushings also offer the other advantages of ball bearings, such as savings from the use of smaller drive motors, gears, and linkages; operating economies due to reduced load; longer life; increased reliability; less servicing; higher operating speeds; and sustained precision.

Standard ball-bushing sizes vary from $^1/_4$-in. shaft size to 4 in. Sizes from $^1/_4$ in. to 1 in. vary in $^1/_8$-in. steps; from 1 in. to 3 in. in $^1/_4$-in steps; and from 3 in. to 4 in. in $^1/_2$-in. steps. Production of some of the smaller sizes is now under way. Volume production of the remaining sizes will be started as rapidly as the tooling for each can be completed.

World's Smallest Bearing

A TINY steel ball slightly larger than the head of a pin and precisioned to a tolerance of 1/25,000,000 in. was developed during the war by the Anti-Friction Bearing Manufacturers Association.

Three of these minute balls are housed in a steel jacket to form the smallest bearing in the world—only 2.7 mm in diameter. The steel balls themselves are $^1/_{25}$ in. in diameter and it takes 111,000 of them to make up a pound.

Until Pearl Harbor, the Germans knew better than anyone else how to make miniature precision bearings. Consequently, many of them were sold in America. However, when the war stopped this source of supply, the United States was suddenly confronted with a situation of not knowing how to make them in the face of tremendous demands from the U. S. Armed Forces for use in special military equipment. Moreover, the special metallurgy involved also had to be developed.

The U. S. Army Air Forces, steel experts, and the American ball and roller-bearing interests pooled their technical knowledge and resources. In less than 10 months they produced a bearing even smaller than the European prototype. Fashioned from chrome-molybdenum alloy, it could rotate at 50,000 rpm.

These miniature bearings are made in a clinical atmosphere resembling the scene of a surgical operation. Never touched by human hands, these minute bearings are made in air-conditioned quarters devoid of dust particles, handled at all times with sterile forceps, lubricated with a single drop of oil from a surgical syringe, and packed in hermetically sealed glass vials for shipment.

American manufacturers are optimistic about the peacetime applications of this midget bearing. Basic research and development is under way for a still smaller steel ball only $^1/_{64}$ in. in diameter capable of attaining more than 150,000 rpm. Industry reports that American watchmakers are unanimous in feeling that the new miniature bearing may almost revolutionize the business. Taking the place of the conventional quartz jewels, the new bearing offers the following advantages: It won't crack; it is sealed and lubricated for life; and it provides finer precision for the watch mechanism.

Miniature Radio

PRODUCTION of what is said to be the smallest radio receiving set being manufactured commercially has been made possible by the postwar development of the tube used so successfully in the VT (variable-time) fuse. Details concerning these subminiature radio tubes have been released by Raytheon

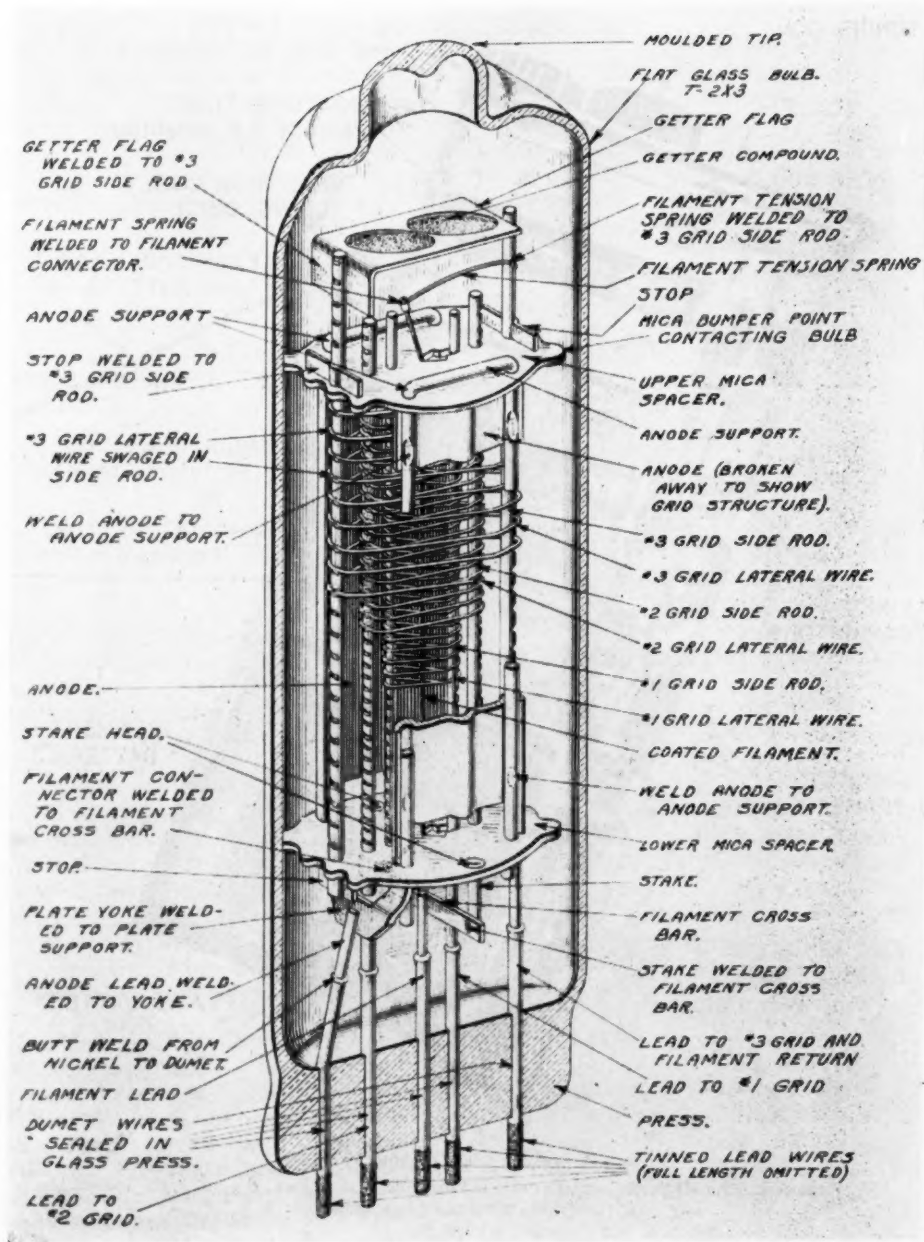


FIG. 2 DETAILS OF A TYPICAL SUBMINIATURE TUBE
(Physical dimensions of tube, $1^9/_{16}$ in. × 0.400 in. × 0.300 in.)

Manufacturing Company, Newton, Mass. The pocket radio is being manufactured by the Belmont Radio Corporation.

The radio, a five-tube superheterodyne receiver, is 3 in. wide, $^3/_4$ in. thick, $6^1/_4$ in. high, and weighs only 10 oz including batteries.

Each tube employed has the same physical dimensions, measuring only $1^9/_{16}$ in. × 0.400 in. × 0.300 in. Weight of the individual tubes varies between 0.07 and 0.09 oz, depending upon the type of tube. Yet one of the tubes known as the converter has nine active surfaces between the two glass walls which are only $^1/_4$ in. apart.

The elements of these subminiature tubes, the filaments, grids, and plates are all located and held together at the top and bottom by very thin pieces of mica which have previously been punched with extremely accurate locating holes. All metal parts are held together by welding. The filament or electron-emitter is made from wire, less than 0.001 in. in diameter, drawn through fine diamond dies. These tubes contain more parts than the tubes used in proximity fuses or hearing aids. About 30 separate parts go to make up one tube. Greatly improved performance will be the immediate benefit to users of equipment requiring small tubes.

Of the five tubes used in the radio set, two are known as radio-frequency-amplifier pentodes, one is a triode-heptode frequency converter, one a diode-pentode detector amplifier, and the fifth is an output pentode similar to the type used in hearing aids. Two of the tubes are actually combinations of two tubes in one envelope. The five tubes require less than $^1/_3$ of a watt to operate and require a miniature B battery of only $22^1/_2$ volts.

It is claimed that these subminiature tubes have long life, require little battery power, and operate from low battery voltages. Performance compares in every way with large

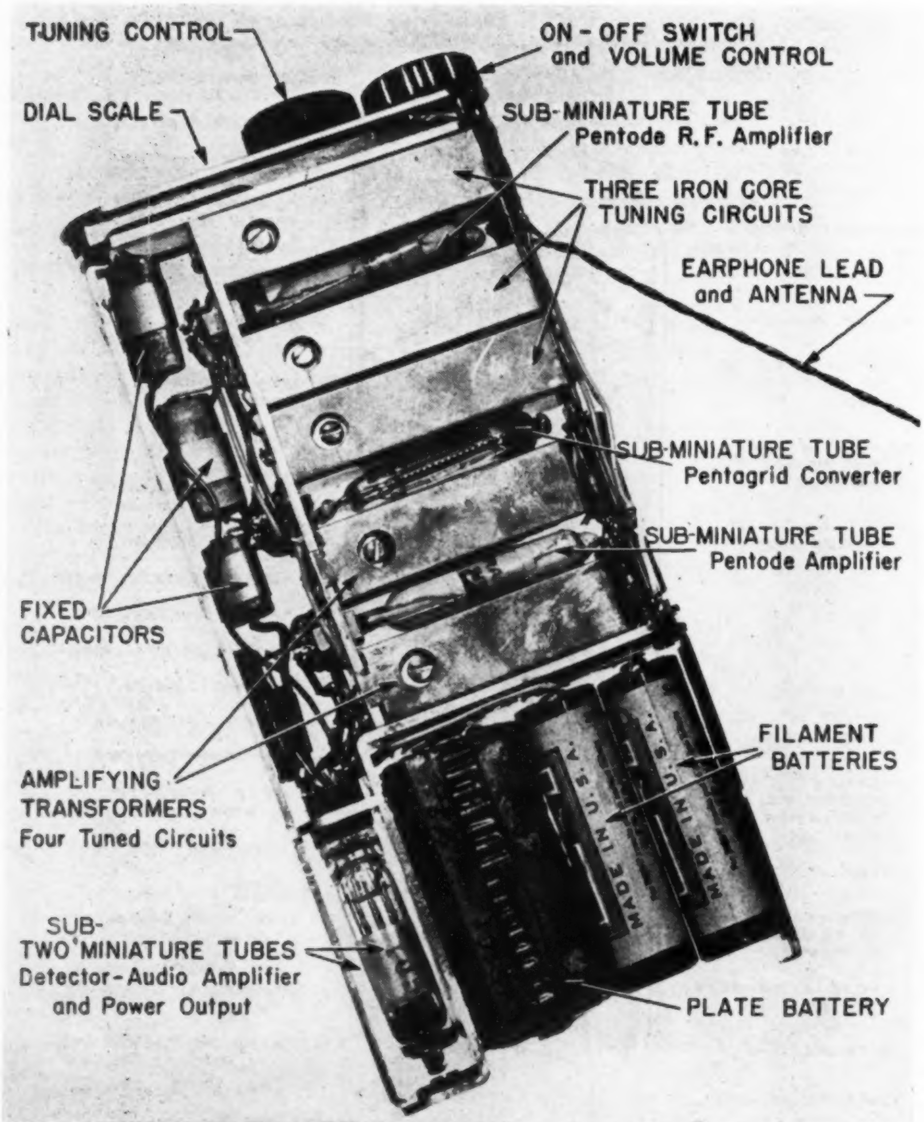


FIG. 3 INSIDE VIEW OF POCKET RADIO

(A 5-tube superheterodyne receiver, the radio is 3 in. wide, $^3/_4$ in. thick, $6^1/_4$ in. high, and weighs only 10 oz including batteries.)

conventional tubes. Because they are manufactured on automatic machinery subminiature tubes will find wide application at little increase in cost.

Besides their use in pocket radios the small tubes will be employed in hearing aids and special medical equipment.

Technical Institutes

A SECOND annual survey of non-degree-granting technical institutes has been prepared by Leo. F. Smith, chairman, Educational Research Office, Rochester Institute of Technology, the results of which appear in the June, 1946, issue of *Technical Education News.*

In making the survey a year ago, Mr. Smith utilized as a starting point the following: (1) The survey made under the sponsorship of the Society for the Promotion of Engineering Education in 1931; (2) the intensive study made by the committee working with Dr. Lynn Emerson and published as "Vocational Technical Training for Industrial Occupations;" (3) a list that had been prepared under the direction of Dean H. P. Hammond, member A.S.M.E., chairman of the Engineers' Council for Professional Development committee on the accrediting of technical institutes; and (4) suggestions made by Edward E. Booher, vice-president of McGraw-Hill Book Company, Inc.

At present all of the schools that had responded to the initial survey plus those which had written in during the year stating that they believed they belonged in a survey of this kind are scheduled. The definition that was used again this year was adapted from the one prepared by Dean Hammond's committee of the E.C.P.D. and is as follows:

"Technical-institute programs are essentially technological in nature and intermediate between those of the high school and the vocational school on the one hand and the engineering college on the other. Curriculums in this field are offered by a variety of institutions and cover a considerable range as to duration and content of subject matter, but have in common the following purposes and characteristics:

1 The purpose is to prepare individuals for positions auxiliary to, but not in, the field of professional engineering.

2 Curriculums are essentially technological in nature, are based upon principles of science, require the use of mathematics beyond high school, and emphasize rational processes rather than rules of practice.

3 Curriculums are briefer, more intensive, and more specific in purpose than collegiate engineering curriculums, although they lie in the same general fields of industry and engineering. Their aim is to prepare individuals for specific technical positions or lines of activity rather than for broad sectors of engineering practice.

4 Training for artisanship is not included within the scope of education of technical-institute type.

5 High-school graduation or the equivalent is required for admission.

To simplify the collection and compilation of data, institutes were classified according to type or control as follows: State maritime academies and federal schools; state and municipal technical institutes; proprietary technical institutes; privately endowed technical institutes; and Y.M.C.A. schools. No attempt was made to survey the industrial-training programs or

the extension-division courses offered by colleges and universities to see if they satisfied the definition that had been utilized. Similarly, no attempt was made to survey the terminal curriculums in junior colleges as information was received that such a study is now being planned under the direction of the American Association of Junior Colleges. During the present survey, questionnaires were mailed to 88 technical institutes and replies received from 74.

The data regarding enrollment in the state and municipal, privately endowed, proprietary, Y.M.C.A. schools, and state maritime academies, and federal schools revealed that for the schools reporting there were 8520 regular day civilian students enrolled as of Jan. 2, 1946. In addition, there were 7879 special and evening-school students, making a total of 16,399. The 8520 regular students during the current school year compare with 10,265 and 3249 regular students enrolled in 1940–1941 and 1944–1945, respectively. These figures are not directly comparable, however, as several schools that reported relatively large enrollments in the earlier years did not respond to the present survey. Similarly, several schools are included in the present survey that were not included in the initial survey.

In addition to the civilian enrollment, 2257 students were enrolled in the maritime academies and federal schools. This compares with 5550 reported enrolled during 1944–1945.

Certain data regarding the state maritime academies and federal schools in the technical-institute category are shown. The large reduction in numbers reported is due to the curtailment of the training program in the U. S. Maritime Service officer schools, and the fact that the U. S. Merchant Marine Cadet Corps has lengthened the course of study to four years and the course is being revised to meet collegiate standards.

The data concerning the state and municipal technical institutes show that the regular day enrollment in the institutes reporting total 1837, which compares with a regular enrollment of 2539 in 1940–1941, and 851 in 1944–1945.

The Milwaukee Vocational School is not one institute but several different schools grouped in one. The enrollment reported is for the evening technical-engineering division, which provides courses for five years beyond high school.

On April 6 Governor Dewey of New York signed a bill providing for the establishment, on an experimental basis, of five technical institutes to be operated entirely at state expense for five years. These institutes will be in addition to the state agricultural and technical institutes at Alfred, Canton, Cobleskill, Delhi, Farmingdale, and Morrisville. It is estimated that they will care for 4500 full-time and 9000 part-time students

The State of Connecticut is also in the process of establishing engineering institutes to provide two years of post-secondary-school study in the engineering fields.

State schools that have active programs under way are Purdue University, The Pennsylvania State College, Rhode Island State College, and the University of Minnesota.

The information received from the privately endowed technical institutes shows that the day enrollment of 4206 compares with a regular enrollment of 2571 in 1940–1941 and 644 in 1944–1945.

Franklin Technical Institute reports that it has recently been examined by the E.C.P.D. committee working under the chairmanship of Dean Hammond. It is interesting to note that although this institute is privately endowed it is publicly controlled.

The Rochester Institute of Technology has a $750,000 three-story building under construction that will be ready for occupancy in September, 1946, and make possible the expansion of enrollment from a former day-school capacity of 850 to approximately 1300.

The Hancock College of Aeronautics, which was listed as a proprietary institution in last year's survey, was rededicated November 1, 1945, as the University of Southern California College of Aeronautics. At present it offers courses primarily in the technical-institute field.

The answers received from the proprietary technical institutes indicate that the regular day enrollment for those schools reporting is 5663. This compares with 5155 students reported in 1940–1941 and 1754 students in 1944–1945. These figures are not directly comparable, however, as several of the schools that reported relatively large enrollments in the earlier years did not respond to the present survey. Several of these institutes that were training large numbers of men for the Armed Forces during the war were in the process of reconverting to take care of the civilian and veteran students when the present survey was made.

The data obtained from the Y.M.C.A. schools that responded to this survey reveal that a total of only 150 regular day students was reported in technical-institute courses.

As a result of having completed two surveys there are certain generalizations which may be drawn. These are as follows:

1 It is apparent that some type of annual survey of technical institutes should be continued. By and large, educators in American higher institutions know very little about the number, purpose, and function of technical institutes. For example, in the excellent survey that Dr. Carter V. Good completed for the American Council on Education and that the Council has just published as "A Guide to Colleges, Universities, and Professional Schools in the United States," the great majority of all of the colleges, universities, and junior colleges are included. Only a few of the technical institutes have been included. This is in no sense a criticism of the work that has been done but again indicates the lack of knowledge that people have concerning technical institutes.

2 Additional thought needs to be given to the definition that has been utilized. It is unfortunate that the present definition, if strictly applied, rules out enrollments in numerous curriculums that are integral parts of some of the technical institutes.

3 It has been suggested that the terminal courses in junior colleges should be included in such a survey. Inasmuch as the American Association of Junior Colleges is now planning such a study there seems to be no reason for duplicating the work of that association.

4 Enrollment in these institutions, like all high institutions, is rapidly on the increase, as is indicated by the total number of 8520 regular civilian students reported this year as compared with 3249 reported a year ago.

Air Research Demonstration

A TWO-DAY air research demonstration inaugurating the General Electric Company's new Flight Test Center in Schenectady, N. Y., on June 21 and 22, brought together more types of advanced aircraft than have ever before been assembled in a scheduled flight program. Co-operating in this first national flight research demonstration held in the United States since before the war were the United States Army Air Forces, the United States Navy, the Marine Corps, various aircraft manufacturers, and some of the major air lines.

Featured in the demonstration flights were Lockheed P-80, I-40 G-E jet-engine-powered Shooting Stars, the type which recently flew nonstop from California to New York City in 4 hr 13 min at an average speed of 584.6 mph.

Also high-lighted in the show was the Bell P-59A jet, the type that made the first gas-turbine-powered flight in the United States.

Many outstanding United States Navy planes participated, among which was the Ryan FR-1, powered in the nose with a

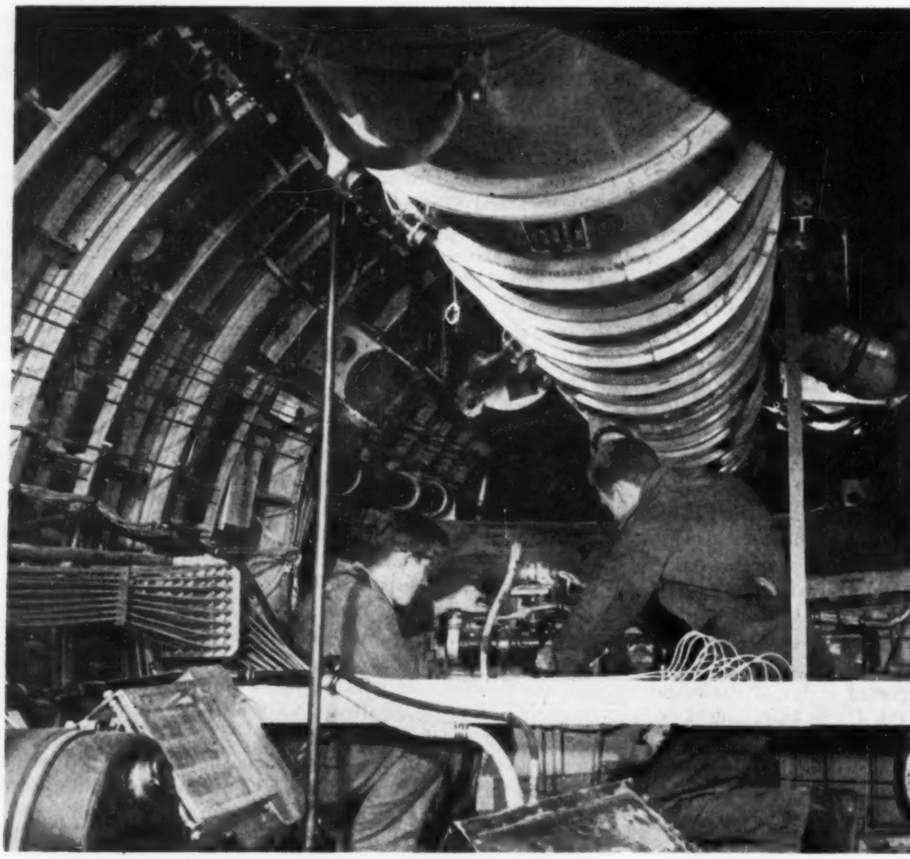


FIG. 4 AN INTERIOR VIEW OF A B-29 SUPERFORTRESS, WHICH HAS BEEN CONVERTED INTO A FLYING LABORATORY FOR THE FLIGHT-TESTING OF NEW AIRCRAFT DEVELOPMENTS

(Here two engineers work on the installation of a jet engine.)

conventional Wright engine that turns the propeller and an I-16 G-E jet engine between cockpit and tail.

FLYING LABORATORIES

Huge bombers, supplied by the Army Air Forces and stripped of their wartime gear, have been converted into flying laboratories for testing in flight the newest scientific and engineering developments in the aeronautical field.

The Flight Test Center includes a huge hangar for the experimental aircraft, two floors of laboratories, workshops, engineering offices, and a control tower for various types of radio equipment.

Presently based at the new center are two B-24 Liberators, a B-29 Superfortress, and an autogiro. These flying laboratories, equipped with the newest scientific and engineering instruments, will enable engineers to conduct tests on all types of aviation equipment under actual flight conditions and thus facilitate the early perfection and production of material under development.

The Superfortress and one of the B-24's are now being used to test powerful jet engines and to develop them for other types of aircraft. The other B-24 flying laboratory is used for testing of the latest developments in the field of radar.

A torpedo-shaped jet, suspended from the bomb bay of a B-29, is operated while the bomber is in flight, instruments recording its operational characteristics. In the B-24, the jet engine is installed in the fuselage, which affords space for the testing of jet engines of varied sizes.

Although all projects now under way at the Test Center involve equipment being developed under Army contract, many of them will be beneficial to commercial and private aviation as well as to the military. New safety features, automatic pilots, pressurized passenger cabins, and radio performance are among the flight-test projects of importance to the nonmilitary aviation.

While many of tomorrow's airplanes with jet propulsion are still guarded as military secrets, engineers have made predictions of low-priced private planes of reasonably high economy, powered by gas-turbine-driven propellers. They also predict helicopters with jet-propulsion gases being emitted from the trailing tips of the propeller blades. It is pointed out that large commercial and passenger lines will be employing planes powered by gas-turbine propeller power plants. Commercial air lines already have expressed interest in obtaining gas turbines to power high-speed transport planes, and war-developed radar is expected to be adapted to peacetime aviation applications.

The flying laboratories, according to engineers, provide a number of facilities and advantages of a ground-test cell, or wind tunnel, with "considerable less cost and greater availability." They also provide a safe means of acquainting design engineers with the problems attendant to flying, and with operation of their design in actual flight.

Overheating Experiments

THE work reported in a paper by J. Woolman and H. W. Kirkby, appearing in the April 26, 1946, issue of the *Iron and Coal Trades Review*, and presented to the Iron and Steel Institute, throws light on the phenomenon of overheating alloy steels and the factors affecting it. Reported was the finding of overheating effects, namely, faceted fractures, in certain forgings made from 3 per cent nickel-chromium-molybdenum, 3 per cent nickel-chromium-molybdenum-vanadium, and 2/2 nickel-chromium steels.

Various preliminary experiments were carried out on the following subjects: (1) The effect of heat-treatment on material showing facets; (2) the effect of rate of cooling from the overheating temperature; (3) determination of minimum overheating temperature; (4) the effect of furnace atmosphere on the formation of facets; (5) the effect of forging on overheated steel.

Subsequent work was designed to throw light on the hypotheses arising from the earlier work and further experiments

consisted of: The examination of 3 per cent nickel-chromium-molybdenum ingot material (i.e., without forging); the effect of further overheating temperature; the effect of the method of steelmaking on the minimum overheating temperature; the effect of aluminum additions on the minimum overheating temperature; and vacuum-melting experiments.

INTERESTING TRENDS DEVELOPING

No definite conclusions, the authors state, can be drawn at this stage of the work as to the actual cause of the faceted fractures obtained when steels are heated to high temperatures. Nevertheless there appear to be several interesting trends developing which are based on the following observations:

(1) There appears to be a minimum temperature above which overheating (synonymous with faceted fractures) occurs over a fairly wide range of temperature.

(2) The minimum overheating temperature varies with different steels and with different casts of apparently the same steel.

(3) The method of steel-making has an important influence on the minimum overheating temperature, basic electric-arc steels having considerably lower minimum overheating temperatures than corresponding open-hearth steels. Furthermore, aluminum additions (and possibly calcium silicide) appear in some cases to lower the minimum overheating temperature.

(4) Vacuum-melting experiments conducted, though limited, indicate that this method of melting can bring about a substantial lowering of the minimum overheating temperature. Thus low minimum overheating temperatures are not necessarily peculiar to the basic electric-arc process.

(5) The limited work carried out on the nickel-chromium-molybdenum ingot samples suggests that the overheating tendencies of a steel are an inherent factor in the material itself and are not the result of outside influences such as the atmosphere during overheating.

(6) While the evidence is limited at the moment, it is fairly certain that facet size, austenitic grain-size at the overheating temperature, and the network revealed by the special H_2SO_4/-HNO_3, etch are interrelated.

(7) The rate of cooling from the overheating temperature is an important factor in the development of faceted fractures. Thus a quick rate of cooling tends to suppress facet formation while the furnace-cooling technique adopted in the present work develops faceted fractures if the reheating temperature is sufficiently high. On the other hand, more recent work has shown that the rate of cooling for certain steels if too slow may also result in facet-free fractures.

(8) Forging from a temperature above the minimum overheating temperature established by straight heating experiments has a considerable influence on the appearance of the final fracture as witnessed by the experiments on the 2/2 nickel-chromium steel. Thus by this means the minimum overheating temperature is apparently raised some 75 to 100 C, and in the case where facets were observed in the fracture, forging also appears to have reduced the facet size considerably. A further important point is that heating to a temperature above the minimum overheating temperature does not necessarily affect the forging behavior of the steel. Moreover, the results also suggest that as long as the amount of reduction is adequate and the finishing temperature low enough, faceted fractures which would be expected from the temperatures employed are eliminated.

On the basis of the observations made, a hypothesis is put forward that faceted fractures are due to a precipitation of an unknown constituent around the austenitic grain boundaries existing at the overheating temperature. Further, this constituent is already present in steels as cast, and with a sufficiently high temperature and a correct rate of cooling, a critical concentration of the constituent is precipitated at the austenitic boundaries existing at that temperature. This concentration results in a series of interruptions of the crack induced in the usual nickel-fracture test giving rise to the well-known appearance of the faceted fracture.

LOW OXYGEN CONTENT A FACTOR

In general, the present results indicate that lower oxygen contents (other factors being constant) are synonymous with low overheating temperatures, although several anomalies exist. The oxygen factor, however, may readily account for the influence of aluminum additions on the minimum overheating temperature although here again the results obtained are not entirely in agreement with the expectations. This is particularly so in regard to the experiments dealing with the influence of aluminium additions to an acid open-hearth cast of nickel-chromium-molybdenum steel. The response to overheating does not increase continuously with the aluminium addition. Further work on the effect of cooling rate may throw some light on the matter.

When oxygen contents are low (as in the basic electric-arc process compared with the acid open-hearth) other elements such as sulphur and phosphorus are lowered so that at least three variables exist in this connection. Present experiments show that sulphur tends to have an influence on the propensity to facet formation. Thus a nickel-chromium-molybdenum steel of basic electric-arc origin was modified so that one ingot was treated with iron sulphide to produce a sulphur content comparable with a Siemens cast.

The results to date show that while there does not appear to be a wide difference in the minimum overheating temperatures, there is a remarkable difference in the ease of producing facets. Thus low-sulphur cast ($S = 0.012$) gives numerous and well developed facets, the formation of which is not affected by the cooling rate from the overheating temperature over wide limits. A high sulphur cast ($S = 0.046$) on the other hand, produces only a few poorly developed facets over a fairly wide range of overheating temperatures. In addition, a high-sulphur cast seems more susceptible to variations in the cooling rate than a low-sulphur cast. Sulphur therefore does appear to affect the facet-forming tendencies of a material. These experiments also suggest that the effect of the rate of cooling on all types of steel—particularly those of open-hearth origin—requires exploration to determine their true susceptibility to overheating.

The minimum overheating temperature may also be influenced by the state of combination of the sulphur, and hence by the manganese content. It is evident that much further work is required and the points raised are being explored.

Accurate Hand Tachometer

BEFORE the war the majority of hand tachometers in use in England were of foreign manufacture, and the cessation of supplies, together with the tremendous expansion of industry during the early stages of the war, resulted in a serious shortage of these invaluable instruments.

A hand tachometer made by Smith's Industrial Instruments, Ltd., London, N.W. 2., and described in the April 12, 1946, issue of *Passenger Transport Journal*, has therefore filled an urgent need and several thousands are already in use in a wide variety of industries.

Of the compensated magnetic type, the mechanism of the

tachometer comprises a rotating permanent magnet which actuates an aluminum-alloy drum carrying the pointer. The magnet is of a special alloy steel and its construction completely eliminates variations resulting from the temperature change over a wide range. Mounted on jeweled bearings, the drum-and-pointer assembly is sturdy though delicately poised and carries a return hairspring of a type evolved and manufactured especially for this instrument.

A speed range of 0–50,000 rpm is provided by a gearbox incorporated in the casing, the recording ranges being selected by a conveniently placed knurled knob. A second design is now nearing the production stage. This is of precisely similar design, but with a speed range of 0–10,000 rpm.

An interesting feature is the incorporation of an idler gear and rocker arm in the drive to provide automatically unidirectional drive to the operating magnet irrespective of the direction of rotation of the driven shaft, while another useful provision is a push-button control to lock the indicating pointer while running at any desired speed, for remote reading. This is particularly useful for checking speeds of shafts in inaccessible or unlighted positions.

The driven spindle, which is carried in a substantial bearing with provision for lubrication, has a hardened squared end for use as a driving center at low speeds while in addition to detachable male-and-female rubber centers a disk is supplied for measurement of surface and cutting speeds.

In use, the hand tachometer gives remarkably steady readings, and it is guaranteed accurate to within plus or minus $^1/_2$ per cent over the normal range of ambient temperatures.

Jig for Drilling Steel Balls

ONE of the most irksome problems in many plants is the matter of drilling holes in small steel balls. An article in *Materials and Methods*, June, 1946, by Thomas A. Dickinson, tells how this has been accomplished by means of a simple box-type drill jig at Consolidated Vultee Aircraft Corporation, Downey, Calif.

The purpose of the jig is to provide two bushings and two indented surfaces, which will simultaneously guide the drill and hold the steel ball in a suitable position. The indented surfaces are faced with thin strips of rubber in order to keep the ball from slipping while drilling takes place; the bushings are situated over and below the indented surfaces.

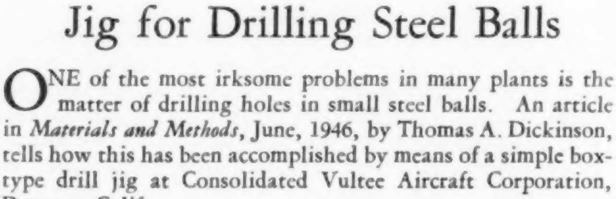


FIG. 5 SIDE VIEW OF DRILL JIG USED IN DRILLING HOLES IN SMALL STEEL BALLS

The upper bushing is mounted in a leaf which can be fastened down over the ball by means of a simple clamping latch; its inside dimensions are slightly greater than the diameter of the drill that is to be used. The lower bushing is a guide bushing, and its purpose is to regulate the depth of the drilling operation. It is situated in a fixed base member.

Because the jig would not normally have to withstand great stresses, most of its parts could be made of wood if necessary. Also, if the leaf were adjustable as well as movable, and if the bushings were of the slip type, the tool could be used in drilling balls of a variety of sizes.

Heat-Treatment Booklet

OF particular interest and value to metallurgists and to all heat-treaters, as well as to production engineers and designers, is a simple, straightforward discussion of the fundamentals of heat-treatment just prepared by the Research and Technology Department, Carnegie-Illinois Steel Corporation, United States Steel Corporation Subsidiary. This two-color, $8^1/_2 \times 11$-in. wire-bound 54-page booklet, illustrated with clearly explained charts, diagrams, and photographs, devotes 26 pages to factors concerning hardness, under which heating, pearlite, bainite, martensite, S-curve, hardenability, and quenching are covered. The next 26 pages relate to toughness, covering such factors as tempering, shape of piece, notch-bar, austempering, stresses, and cracking. Six general rules for quenching, tempering, and austempering summarize the detailed explanations; these are:

1 The useful structures in hardened pieces are bainite and tempered martensite. To obtain either of these structures, the piece is heated to secure adequate solution of carbides and then quenched so rapidly that the formation of pearlite or upper bainite in the 1000-F zone is avoided, bainite or martensite being formed then at lower temperatures.

2 When quenching a specific size of piece, the avoidance of pearlite is made easier if its possible formation would require more time. The slower rate of pearlite formation is obtained by adding alloys. If the piece is fully hardened (martensitic), the hardness is affected but little by the alloys, being governed almost exclusively by the carbon content.

3 For a given size of piece, avoidance of pearlite or upper bainite is also aided by employing a greater severity of quench. This is obtained by avoiding excess scale on the piece, by employing the quenching liquids which generally show a greater severity of quench, and by agitating either the quenching liquid or the piece being quenched. It is well to remember that the old hand agitation during quenching was very effective, and it may be desirable to duplicate the results in modern mechanized equipment.

4 When measuring toughness, remember that the results are affected profoundly not only by the magnitude of the stress imposed, but also by its nature and direction, and consequently also by the shape of the piece. A laboratory test should always simulate a service test as closely as possible.

5 Toughness in martensitic structures is obtained by tempering the quenched piece.

6 Bainite structures, obtained in austempering, are inherently tough and above 48 Rockwell C offer a combination of strength and toughness superior even to tempered martensite.

A valuable table of Jominy end-quench distances vs. bar diameters for six different quenching conditionsc oncludes this new booklet. Copies may be secured from any office of American Steel and Wire Company, Carnegie-Illinois Steel Corporation, Columbia Steel Company, National Tube Company, or Tennessee Coal, Iron, and Railroad Company.

Underground Gasification of Coal

IN the Soviet Union, according to the June, 1946, *Science Bulletin* of the American-Soviet Science Society, the first experiments of subterranean gasification of coal were made in 1931, and seven years later the first industrial plant for the subterranean gasification of the sloping strata of brown coal, or lignites, started operations. A method had been worked out by a group of Soviet specialists headed by a young engineer.

As a result of theoretical and experimental research conducted in 1939–1941, a group of scientific workers in the Power Institute of the Academy of Sciences of the U.S.S.R. elaborated a new method of the subterranean gasification of horizontal and sloping strata of lignites.

This method has been applied on an industrial scale since 1943. It is based on the ability of the gas stream to penetrate through the pores and crevices of a coal seam. The method consists in drilling vertical wells from the surface to the coal stratum.

The task of scientific research, at present, is the further perfection of methods of subterranean gasification of coal in order to increase the efficiency of the utilization of coal deposits without the use of heavy underground labor.

The possibility of obtaining directly from underground huge quantities of gas, even from inferior coals with a high ash content, opens up wide prospects of using gas turbines in place of steam units for the further development of electrification.

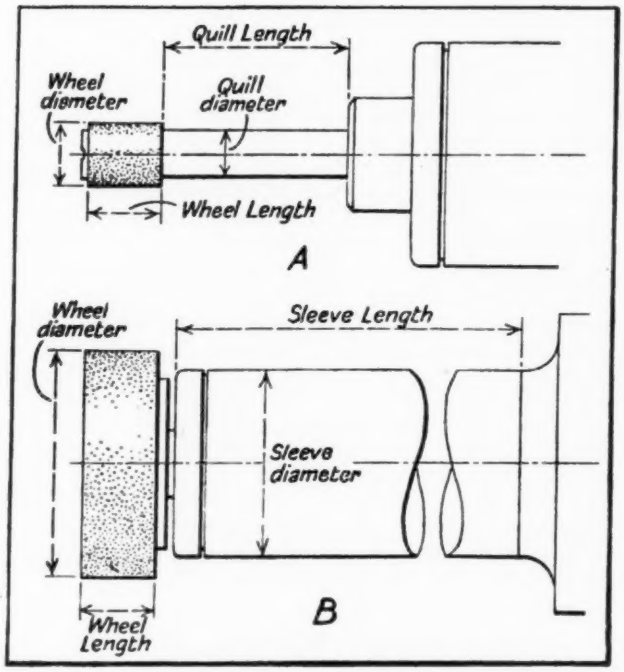


FIG. 6 (*a*) QUILL-TYPE SPINDLE FOR INTERNAL GRINDING. (*b*) SLEEVE-TYPE SPINDLE FOR GRINDING LONG BORES OF LARGE DIAMETER

Internal Grinding

SOME considerations in internal grinding are set forth in an article appearing in the June, 1946, issue of *Machinery*. The article reveals that grinding probably introduces more governing factors than any other machining operation, such as, the material being ground; amount of stock to be removed; accuracy and finish required; diameter of work in relation to wheel; speed, grit, grade, and bond of wheel; rigidity of machine; and in-feed and traverse speeds. All these factors have an influence on the rate of production and the finish of the ground work. Additional factors are introduced in internal grinding, especially when the holes ground are of small diameter, because for this work very high-peripheral, grinding-wheel speeds are necessary to obtain the required surface speeds.

The usual recommendation for a surface speed of from 5000 to 6000 ft per min. would, in small holes, require a higher spindle speed than is generally practicable. For example, a $^3/_8$-in diameter wheel would have to be driven at approximately 50,000 rpm to obtain this surface speed. While such speeds are not impossible, a very light grinding spindle is required and it is difficult to obtain the necessary rigidity.

Tables have been prepared giving quill sizes and maximum quill lengths for given grinding-wheel sizes. So many factors are involved, however, that figures from a table cannot be applied to all applications, but can merely be used as a working basis. Generally speaking, for the grinding of small bores up to $^3/_4$ in. in diameter, the use of a fairly low surface speed with a fairly hard wheel has been found more satisfactory than the use of high speeds with a softer wheel.

Mounted wheels are used for very small bores. Except in special cases, however, they should not be employed on sizes above $^3/_{16}$ in. in diameter, because not only are they more expensive, but the wheel is easily broken away from the shank, thus requiring frequent replacements.

Varying the work speed does not have the same effect in internal grinding as in external grinding because, as may be easily understood, a $^3/_8$-in diameter bore requires a very wide variation on peripheral speed to produce a substantial change of surface speed. Furthermore, the arc contact between the wheel and the work also remains fairly constant, the wheel usually being changed to suit the diameter of the bore. Work speeds between 150 and 200 ft per min will usually be found most satisfactory.

The following rules are suggested for making changes in grinding wheel and work spindles to suit individual work: (1) Reducing the grinding-wheel speed is equivalent to using a softer wheel. (2) Increasing the work speed is equivalent to using a softer wheel. (3) The harder the material, the softer the wheel required. (4) The larger the wheel or the closer the grinding-wheel diameter is to the diameter of the hole being ground, the softer the wheel required. (5) The higher the traverse speed, the harder the wheel required. (6) An interrupted bore surface, such as a bore with a keyway, requires a harder wheel. When making changes in speed to suit the work, it is preferable to alter the work and traverse speeds rather than to lower the spindle speed, and in any case, it is usually more convenient.

Three types of wheel heads for holding grinding wheels are normally used for the internal grinding of small holes: (1) The removable-quill type, Fig 6*a*, in which the quill size can be varied to suit the work. This type is used when a large variety of work is handled. (2) The solid spindle or "naked" style, in which the wheel is mounted directly on the end of the spindle extension. This type is suitable for maximum production on one size of hole, or at least a limited range of bores. (3) The sleeve type, Fig 6*b*, for grinding larger diameters and long bores. This type has bearings immediately in back of the wheel, resulting in maximum rigidity, especially for long bores, and is also suitable for face-grinding. It is false economy to expect one size of grinding spindle to cover a wide variety of work,

except for toolroom operations, when maximum production is not the first consideration.

One of the most important points in high-grade internal grinding is correct lubrication of the spindle. A good quality of light spindle oil must be used. A surprising number of spindles are ruined, or their efficiency impaired, by the use of improperly selected oil. In one plant it is customary to paint oilcans containing spindle oil with a distinctive color.

Another common cause of failure on some types of wheel heads is overtightening the spindle in its bracket. It should be clamped very lightly, with just sufficient tension to prevent the spindle from moving. The slight distortion caused by overtightening puts an excessive strain on the bearings, with consequent rapid failure, due to the very high speeds at which the spindles operate. The spindles should also be a good fit in the bracket, so that complete contact is obtained. This, of course, does not apply to spindles that are fitted to the machine as a unit, or to those wheel heads with two-piece body and tapered bearing-sleeve construction.

Care should be taken to use high-grade belts that run as nearly true as possible. An inferior belt can cause a surprising amount of vibration at the high speeds used, and this is transmitted almost directly to the wheel and work.

Flash Welding

MACHINES which can flash-weld steel cross sections up to 25,000 sq mm (about 38 sq in.) have been developed and used by German technicians, according to a report released by the Office of the Publication Board, Department of Commerce.

The report is a translation of a German book on the production technique and quality of flash-welder joints, published in 1936 by Dr. Hans Kilger, a German engineer. The translation was prepared in 1944 as part of a National Defense Research Committee research project at the Battelle Memorial Institute, Columbus, Ohio. Comments by the American researchers are included.

The book is said by American experts to be "the most complete publication on flash-welding that has appeared in the literature to date." The researches described in this volume were all made upon the hand-operated, type WS 6 machine, which takes cross sections up to 6.2 sq in. No data on the larger motor-driven machines appear in the present report. However, they are in use in Germany.

Flash-welding involves bringing two pieces of metal together and charging them with an electric current of high amperage and low voltage. The proximity of the pieces causes a short circuit, with attendant heating of the metal.

Preheating, the first step in the process, is accomplished by bringing the ends of the pieces together and separating them several times in succession. A short circuit is caused each time the pieces are brought together. The heat resulting from the short circuit causes the formation of a bridge of molten metal between the parts to be welded.

The parts are then drawn apart slightly, but left sufficiently close together to arc. Flashing now begins. Particles of molten metal and any impurities present in the metal are thrown out. This "burn-off" period lasts about 25 sec.

The weld is completed by bringing the two pieces of metal together under pressure ("upsetting"). Pressure of about 4100 lb per sq in. is applied for a round steel rod 1.8 in. in diameter.

In a machine taking a steel cross section of 4000 sq mm welding is accomplished in 45 sec.

Dr. Kilger's book includes systematic studies of the various steps in the flash-welding process and of their effects upon hardness, fatigue strength, tensile strength, and impact resistance.

The investigators state that Dr. Kilger's data on the effect of temperatures and upset pressures on the quality of flash-welded joints, as well as his methods of obtaining these data, are particularly instructive and should provide a basis for further research along these lines. The German author, however, admits that his short-cut method of fatigue testing is acceptable only for comparative purposes. Acceptable and more modern methods of testing should be made.

The report contains 180 pages including 75 figures and photographs and 15 charts.

Correction

THE Bureau of Ships, Navy Department, has called our attention to the fact that the item "Dehumidifying Navy Ships," MECHANICAL ENGINEERING, June, 1946, page 562, credits Cargocaire Engineering Corporation with development of the dehumidifying system described. We are informed that while Cargocaire was first to develop a dehumidifying system for vessels carrying cargo, the development of both systems and equipment for the preservation of inactive vessels by means of dehumidification was primarily by the Bureau of Ships, and that in addition to Cargocaire, the Pittsburgh Lectrodryer Corporation, C. M. Kemp Manufacturing Company, Davison Chemical Corporation, and the Friez Instrument Division of Bendix Aviation Corporation, have also manufactured equipment for this purpose.

Trends in Agricultural Mechanization

(*Continued from page 726*)

created a demand for custom-built units, or specialty machines, like hop pickers, beet harvesters, green-crop harvesters, special processing equipment, and the like.

Thus far, my remarks have been directed toward mobile farm equipment. Brief reference to electricity in agriculture seems merited. California farmers use approximately 1 kilowatt-hour of electrical energy for every drawbar-horsepower-hour delivered by farm tractors. There are on the farms of this state, close to a half-million electric motors of all sizes, and these constitute a very important part of the useful stationary power on the farm. Furthermore, electrical energy is one form of energy that is available to farmers at lower cost than in the past. Electrical service on the farm is highly important, but its field of application is for heat, light, and power for stationary operations.

The mechanical engineer engaged in the farm-implement field has less trouble with the actual physical problems of design than with the problems of machine functions. The latter are often related to the biological responses of plants and animals in which the conventional technical engineer has had little opportunity for experience. The agricultural engineer is no doubt best situated to study, define, and specify the functional requirements of farm machines and then he must co-operate with the mechanical engineer to produce a truly functional and technically designed unit in all of its parts. One does not take the place of the other, but working together, both are able to render better technical service to agriculture.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Compression Distillation

Comment by Robert V. Kleinschmidt[1]

The author has given a conservative, matter-of-fact account[2] of the operation of the compression-distillation units developed for the Navy and the Marine Corps. It may be of interest to know a little more of the real significance of this development to the Navy, and some of the reasons which made it particularly valuable for naval use.

The work was started by the writer as the result of a suggestion to Arthur D. Little, Inc., from Rear Admiral Hooper (now retired) that the Marine Corps needed a suitable water supply for barren Pacific islands. The specifications were simple—a unit which when set on the beach with a barrel of gasoline would produce the maximum amount of potable water with a minimum of attention.

The writer had been studying the idea of a "heat pump" for 20 years and, on being presented with this problem, recognized at once that it was the ideal condition for such a unit, namely, a low thermal head and very large quantities of heat to be handled; also that the rotary positive-displacement blower was the ideal compressor for this purpose.

It was somewhat fortuitous that the first laboratory model was driven by an electric motor, since the Marine Corps unit would obviously be engine-driven. However, the electric drive at once showed that such a drive was both feasible and economical. Therefore, when Commander J. O. Huse, U.S.N., saw the unit demonstrated, he at once visualized it on board a submarine, at least as a means of supplying pure battery water. The efficiency of the full-size units proved to be such that they displaced completely the exhaust-heat evaporators then in use, and provided adequate and dependable water supply for even extended cruises. By increasing the comfort of the crew, reducing the amount of water that had to be carried, and improving the quality of battery water, this development may have increased the efficiency of our submarine fleet by as much as 50 per cent.

Credit for this goes primarily to the officers of the Navy, who fearlessly staked their careers on this radically new development.

Among the features which were found to be inherent in the apparatus as developed were extreme purity of the water distilled directly from sea water; sustained high capacity even as the efficiency fell off due to scale formation; very little attention required; as well as low energy consumption. In the limited space permitted in submarines, the design was restricted so that the full possible economy of the process was not obtained. The theoretical power required is less than 3 whr per lb of fresh water, and for some purposes economies of as low as 7 whr per lb are justified.

Industrially this development opens up a vast new field for the use of very pure water, water that is now available only for medical uses, water that is absolutely sterile, and contains less than one tenth of the impurities allowed in the Navy specification for doubly distilled battery water. This water may now be had at a cost of only two or three times that of ordinary city tap-water. Thus, the Navy has sponsored a significant contribution to the arts of peace.

Comment by Fred A. Loebel[3]

The performance curves shown in Fig. 6 of the paper, conform closely with data compiled from some 20,000 hr of testing of gasoline-engine-driven compression evaporators manufactured by the writer's company.

A considerable number of tests have also been made of similar machines, which are Diesel-engine driven. These models were primarily designed for higher outputs per unit of evaporator surface, and conservative engine loads in the interest of maximum reliability. Although both of these factors tend to work against high distilled water-to-fuel ratio, an appreciable gain in economy has also been realized; attributable largely to the higher efficiency of the Diesel engine, as compared with the gasoline engine. Typical performance curves in Fig. 1 of this discussion, show an average (for 700 hr of operation on sea water) of approximately 200 lb of distilled water per lb of fuel, as compared with an average ratio of about 160 for the gasoline-engine units.

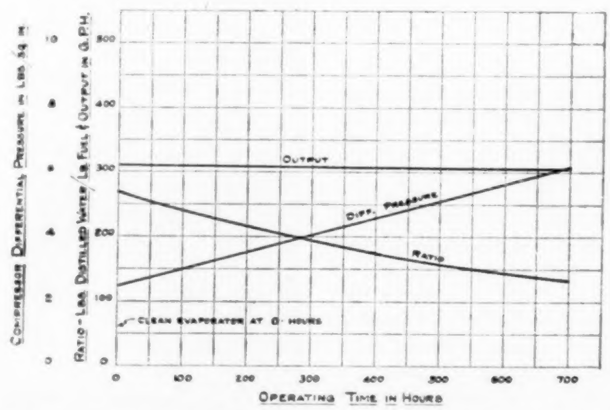


FIG. 1 SEA-WATER PERFORMANCE OF DIESEL-POWERED COMPRESSION-DISTILLATION UNIT

It will be noted from the initial operating conditions in Fig. 1, herewith, that the fuel input, corresponding to a ratio of 265 and production of 310 gal per hr is 9.7 lb per hr. Based upon fuel at 18,000 Btu per lb and a heat recovery for process of 65 per cent (from engine-jacket water and shaft horsepower), the net heat input

[1] Commodore, U.S.N.R. (inactive). Stoneham, Mass. Mem. A.S.M.E.

[2] "Compression Distillation," by Allen Latham, Jr., Mechanical Engineering, vol. 68, 1946, pp. 221–224.

[3] Project Engineer, Cleaver-Brooks Company, Milwaukee, Wis.

is about 44 Btu per lb of distilled water. At this relatively low value, fairly efficient heat exchange for feedwater preheating is required to sustain normal operation at low ambient temperatures with 32 F feedwater, and yet provide a little excess heat for control purposes. About 15 deg F temperature difference is required between the incoming and outgoing liquids for satisfactory operation under these extreme conditions. The heat balance for the initial operating conditions in Fig. 1, with a scale-free unit is given in Table 1.

TABLE 1 HEAT BALANCE FOR INITIAL OPERATING CONDITIONS

		Btu per hr
	HEAT INPUT	
1	Engine brake horsepower (compressor and pumps)	48400
2	Engine jacket cooling water	65600
3	Engine exhaust gases and radiation	61000
	Total	175000
	HEAT LOSSES	
1	Brine overflow (200 gph, 15° FTD)	25000
2	Distilled water (310 gph, 15° FTD)	38600
3	Venting	25000
4	Radiation and unaccounted for	25400
5	Engine exhaust gases and radiation	61000
	Total	175000

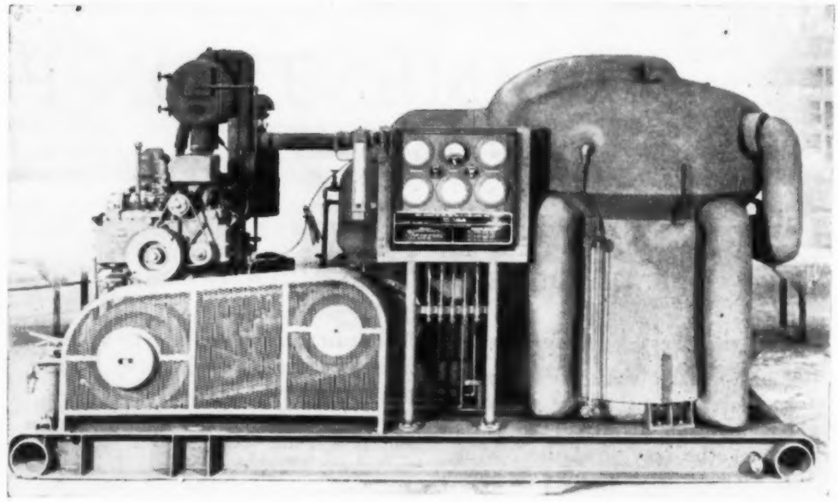


FIG. 2 CLEAVER-BROOKS 375-GPH DIESEL-POWERED COMPRESSION-DISTILLATION UNIT

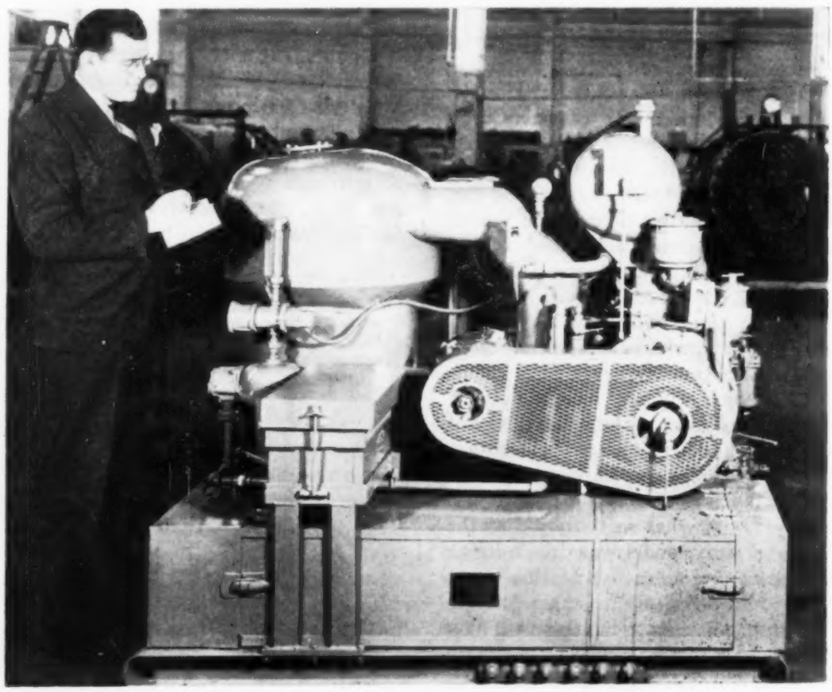


FIG. 3 CLEAVER-BROOKS 90-GPH DIESEL-POWERED COMPRESSION-DISTILLATION UNIT

The machine is shown in Fig. 2 of this comment. A three-lobe Connersville-type compressor with labyrinth seal rings is used. Although the output of the machine in Fig. 1, is slightly over 300 gph, other tests have shown that the capacity can be increased to 375 gph with only an 8.5 per cent reduction in fuel economy. On some waters, with scaling characteristics less severe than sea water, output can be stepped up to over 400 gph. The compressor is designed for a maximum evaporator capacity of 500 gph.

A smaller, 90-gph portable machine is shown in Fig. 3 of this comment.

From a theoretical standpoint, much higher fuel economies can be realized than indicated by the curves in Fig. 1. Ratios of 325 lb of distilled water per lb of fuel have been obtained during shop tests of experimental equipment.

COMMENT BY WILLIAM P. SAUNIER[4]

The distillation method presented in this paper has proved itself particularly well adapted to the "package plant" idea which has been so greatly developed due to the necessities of the war. Because the design of equipment has from its inception been directed toward economy of space, complete co-ordination of elements and simplicity, an excellent compact unit has been produced.

The economy of the process, as compared with common methods of producing clean distillate, is startling. In order to see how the economy compares with that of a single-effect turbine-extraction evaporator in a central station, an analysis was made of the operating costs involved in the two systems.

The steam cost at the throttle is 30 cents per thousand pounds and the cost of energy is taken as 3 mills per kwh, since the equipment would not be required to operate at times of station peak load, and only increment cost would be incurred. The added throttle steam required to operate the evaporator at the normal rate was calculated from station heat-balance data. For the compression-distillation system, the power input to the compressor was taken as 35 Btu per lb of distillate and 33 Btu per lb were considered to be extracted from a suitable extraction point of the turbine and added to the system. Since the distillate leaving the system would be at a temperature near that in the condenser, it was taken as being discharged to the condenser. The equiva-

[4] Project Manager, Jackson & Moreland, Boston, Mass. Mem. A.S.M.E.

lent throttle steam required to permit heating the distillate from condenser temperature to that in the deaerating heater (the point of discharge from the extraction steam evaporator) was calculated and the cost charged to the system.

The operating cost for the extraction-steam evaporator when delivering 8420 lb of makeup per hr was found to be 65.7 cents per hr. The cost for the compression-distillation system for producing the same quantity of makeup was found to be 47.6 cents per hr. Since the equipment would be called upon to operate 6000 hr per year at the normal rate, the saving effected by this newly developed system would be a considerable item.

Comment by F. B. Schneider[5]

It is gratifying that the author's company succeeded in applying a purely theoretical thermodynamic principle to the mass production of a unit with such outstanding results. The theory of the "compression distillation," or of the internal transfer of heat in a thermodynamic cycle has been known for some time but only scattered applications in the chemical industry, food industry, and the oil industry can be found. Test results of such installations are always subject to suspicion that some unknown but influential factor has not been accounted for in analyzing the test results.

The development of the compression-distillation unit furnishes data which extend over a large number of different plants so that any conclusion or test results could be checked many times. Until other test data become known or, unless tests of similar units applied in different fields are published, it is not possible to criticize the test values furnished in this paper. The writer believes that the paper furnishes practical data for an important thermodynamic principle for which the whole industry will be indebted to the author.

As far as the design of the compression-distillation unit is concerned, the illustrations show the normal trend of technical development. The first plant is an assembly of single units based upon the realization of the theoretical principles. The production model shows the influence of the method engineer in harmonizing the requirements of pure science with streamlined efficient production.

Although the difficulty of obtaining a suitable compressor was mentioned, it is believed that additional shop problems were encountered with the evaporator, the heat exchanger, and various valves and fittings. It would be interesting if the author will explain the problems and describe the solutions he and his company discovered.

It is hoped that future applications of compression distillation will spread to many additional fields. In order to mention just one of them, the spoiled taste of food in restaurants of eastern cities, where the drinking water is chemically treated, calls for the service of such units. In future years the general public may not be so willing to accept the taste of chemically treated drinking water and may ask for the installation of giant compression-distillation plants to obtain pure water.

[5] Design Engineer, Locomotive Engineering Division, General Electric Company, Erie, Pa. Junior member, A.S.M.E.

Author's Closure

The illuminating comments by Messrs. Kleinschmidt, Loebel, Saunier, and Schneider are greatly appreciated.

Commodore Kleinschmidt's statement that "the theoretical power required is less than 3 whr per lb of fresh water" may cause the inquisitive reader to speculate as to just what determines the theoretical power requirement. The primary determining factor is temperature differential between the compressed vapor and the boiling solution. This temperature differential determines the pressure differential which determines the power required for compression. The power required for compression would be sufficient to establish a heat balance in a theoretical unit, which would be insulated perfectly, would have no heat loss by way of vents, and would have the same temperature differential in the heat exchangers as in the condenser evaporator. On this basis, 3 whr per lb of fresh water would suffice to operate a unit with a differential temperature of about 7 F. Most of the units constructed thus far have operated at temperature differentials of 10 to 15 F. The economics of industrial practice usually call for much higher temperature differentials, say, 30 F. At 30 F the theoretical power requirement would be nearly 14 whr per lb.

As Mr. Loebel points out, there is no question but that the Diesel-engine-driven unit is entitled to a very high rating from the standpoint of economy and dependability. Early in 1942 the author's company ran a Diesel-engine-driven unit on test for several hundred hours. The results were so impressive that the question of gasoline-engine drive vs. Diesel-engine drive was taken up for critical review with the various equipment boards of the Armed Services. The decision to continue exclusively with gasoline-engine drive was based on requirements to obtain maximum mobility of the unit and to use the same grade of fuel as was being used in automobiles. It is interesting to note that later, as the war progressed to the point where the requirements of semipermanent or permanent bases became prominent, a strong demand for Diesel-engine-driven units developed. At present, practically all of the units under construction are either Diesel or electric drive.

Mr. Saunier's development of operating costs as applied to central-station work is most interesting. His use of the 68-Btu per lb figure places his calculation on a very conservative base. It is hoped before long central station installations will have been made in this country and actual results can be reported.

Mr. Schneider's suggestion that more of the problems of development be discussed cannot be fully discussed here for lack of space. As is often the case, a large portion of these problems had no relationship to the particular process being developed. A typical example of this occurred when a sea-water pump failed during a field test. Investigation disclosed that the pump manufacturer had assembled this "all-bronze" pump with a carbon-steel setscrew and key to hold the impeller on the shaft. Electrolytic corrosion had made short work of these two tiny parts and we had to make a hasty fifty-mile drive to obtain suitable replacement parts.

Allen Latham, Jr.[6]

Glued-Laminated Arches

Author's Closure[7]

The use in construction of glued-laminated structural members deserves greater emphasis, especially with the current timber scarcity. It appears highly desirable to weigh carefully the elements required for proper fabrication of glued-laminated members, with the view of preventing undue emphasis being placed on certain phases, as surfacing, when other phases, such as gluing technique may be much more important. If the use of sawed-faced lumber saves material and labor, it would appear logical, as Professor Dietz says, to employ carefully and smoothly sawn laminations for glued members in which the shear stresses are not severe enough to be the controlling factor in design, and reserve the use of planed surfaces for members in which the utmost in shear strength must be developed. If present sawing methods in certain woodworking plants is too crude to result in satisfactory sawed surfaces for glued-laminated lumber, as sug-

[6] Alfred D. Little, Inc., Cambridge, Mass.

[7] Discussion published in Mechanical Engineering, vol. 68, 1946, pp. 472–473.

gested by Mr. Wilson, it would appear that the method of sawing, rather than the use of sawed laminations, should be condemned.

The boomerang arches in the Group Instruction Room of the Administration Building, which have laminations with one sawed face, are varnished. The Administration Building is heated by direct steam radiation designed to heat the building to 70 F. and is without a humidifying system. By September, 1945, the arches had been in place through three summers and two winters, and showed no evidence of distress to the glue joints due to tensile stresses in the glue lines caused by changes in the moisture content of the wood.

The data presented in the paper, drawn from various technical bulletins of the U. S. Department of Agriculture, has not been distorted in any way. Mr. Wilson believes these data not adapted to the comparisons made, but the conclusions drawn seem obvious, whatever the original purpose of the data may have been. Mr. Wilson incorrectly states that the assumption was made by the author that the load-deflection diagrams for the test specimens were identical with the computed load-deflection diagrams presented, Figs. 7(*a*) and (*b*). It was stated in the paper that Mr. Wilson had advised the author, ". . . . . it can be expected that the strength and stiffness of well-glued laminated beams is approximately the same as the strength and stiffness of solid beams of equivalent grade, density, and moisture content." It was also pointed out that, "Although . . . certain assumptions were made to determine the indicated loads and computed shears developed in the glue joints, it is believed that these values are of the proper order."

The photograph, Fig. 11, indicating defects in workmanship that appeared in one arch did not show the laminations as clearly as the original photograph. This variation in thickness of the laminations was due to an increase in thickness at certain scarfed splices that had not been properly finished before the assembled lamination was included in the arch.

As Mr. Hanrahan points out, the final criterion of a product is the service it renders. It is hoped that the service records of the arches presented together with the test data and laboratory investigation by others will stimulate the use of arches having sawed laminations. They have a place as structural members.

E. A. DUBIN.[8]

[8] Chicago, Ill.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretation of this Committee formulated at the meeting of May 10, 1946, and approved by the Council on June 17, 1946.

CASE No. 1026

(Special Ruling)

Inquiry: The requirements in the Code for Low-Pressure Heating Boilers for relieving excessive pressure are such that it has been found impractical to meet them by using currently available relief valves on hot-water heating boilers connected to closed systems. Until such time as revisions shall be incorporated in the Code, what requirements shall apply?

Reply: Each hot-water heating boiler connected to a closed system and each hot-water supply boiler shall be equipped with one or more relief valves set to relieve at or below the maximum water working pressure stamped on the boiler. The capacity of the valve or valves shall be sufficient to relieve the pressure created by thermal expansion of the water so the pressure of this source does not increase to more than 10 lb above the maximum water working pressure of the boiler. In no case shall the relief capacity of such a valve or valves be less than $^1/_2$ lb of water per hour per 1000 Btu of boiler capacity.

If the above described relief valve or valves cannot relieve in the form of steam all the heat that can be absorbed in the boiler, then the boiler shall also be equipped with a steam safety valve or valves which will relieve all the steam that can be generated in such a boiler without permitting the pressure to rise more than 5 lb above the safety-valve setting. Such valves shall be set 15 lb above the maximum water working pressure for boilers with water working pressure up to and including 50 psi, and valves shall be set 20 per cent above the maximum water working pressure for boilers with water working pressures above 50 lb and up to 160 lb. Such safety valves shall be built without guide wings on the pressure side of the valve. They may be A.S.M.E. standard valves, or they may be designed and built to comply with the provision of Par. H-51 or H-104 of the Code, except that they shall be tested and rated at 3 per cent over the set pressure. Because steam safety valves when used on hot-water heating systems may leak after testing in service, it is suggested that in lieu of that practice, such valves be periodically removed from the boiler for testing and repair or readjustment after which they shall be reinstalled.

Books Received in Library

TIMING A CENTURY, HISTORY OF THE WALTHAM WATCH COMPANY. (Harvard Studies in Business History II.) By C. W. Moore. Harvard University Press, Cambridge, Mass., 1945. Cloth, $5^1/_2 \times 8^3/_4$ in., 362 pp., illus., diagrams, charts, tables, $4. In 1850 the firm of Dennison, Howard, and Davis was formed to manufacture watches by the then new system of machine production of interchangeable parts. The history of the concern from that time to its present status as the Waltham Watch Company is told in detail, together with the careers of the notable men who played their part in its development. There are some 35 pages of notes and references and a partial list of watch manufacturers in the United States in chronological order is appended.

VORLESUNGEN ÜBER DIFFERENTIAL GEOMETRIE UND GEOMETRISCHE GRUNDLAGEN VON EINSTEINS RELATIVITÄTSTHEORIE. Vol. I, Elementare Differentialgeometrie. By W. Blaschke. Third enlarged edition, prepared by G. Thomsen. Dover Publications, New York, N. Y., 1945. Cloth, $5^1/_2 \times 8$ in., 322 pp., diagrams, tables, $3.50. Essentially a textbook of differential geometry in a Euclidean space of three dimensions, this volume provides also an introduction to original research in the field. The following is a partial table of contents: Introduction-vectors; theory of curves; elements of the theory of surfaces; invariant derivatives on a surface; geometry on a surface; problems of surface theory in the large; extremal properties of curves and surfaces; line geometry. Particular emphasis is placed on the relations between differential geometry and the calculus of variations.

A.S.M.E. NEWS

And Notes on Other Engineering Societies

Wartime Developments and Postwar Industrial Outlook Reviewed at A.S.M.E. 1946 Semi-Annual Meeting Held in Detroit, Mich., June 17 to 20

Committee on Nuclear-Energy Application Makes First Report

A SENSE of satisfaction over the industrial record of the war years, a determination to keep alive the partnership of industry and the Armed Forces born of the war, and the awareness of a revolutionary new energy source on the industrial horizon, pervaded the 1946 Semi-Annual Meeting of The American Society of Mechanical Engineers with The Engineering Institute of Canada participating, held at Hotel Statler and Book Cadillac Hotel, Detroit, Mich., June 17 to 20, 1946.

More than 1000 engineers and engineering executives attended the meeting during which engineering developments of the war were discussed and evaluated, seven of the major industrial plants in the vicinity of Detroit inspected, and many broad policies for the future proposed for the engineering profession by leaders in industry and high-ranking representatives of the U. S. Navy and the ground and air forces of the U. S. Army.

D. Robert Yarnall, president, A.S.M.E., announced as the theme for the next half year of Society activity "The Public Responsibility of the Engineer," and urged members to give expression to their ideas in the planning of papers and meetings.

E.I.C. Participates

The Engineering Institute of Canada was officially represented at the meeting by its president, J. B. Hayes of Halifax, Nova Scotia, Can., and its secretary, L. Austin Wright, of Montreal, Que. Mr. Hayes was introduced to members of the A.S.M.E. at the general luncheon on Monday, June 17. In his brief talk, Mr. Hayes expressed his "personal delight" in renewing old friendships among American engineers and in visiting again the "Canadian" city of Detroit. To all Americans he extended an invitation to visit the American city of Windsor and his own American city of Halifax, Nova Scotia.

Keynote Address

J. W. Parker, past-president A.S.M.E., president, The Detroit Edison Company, in his keynote address at the general luncheon, Monday, June 17, said that the "greatest responsibility facing men of applied science" today is the opportunity available to the engineering profes-

SENATOR MCMAHON SPEAKING AT THE NUCLEAR-ENERGY APPLICATION DINNER, JUNE 17
(*Left to right,* D. Robert Yarnall, A. L. Baker, Senator Brien McMahon, Alex D. Bailey, and Admiral H. G. Bowen.)

sion to contribute their time and effort and thereby to influence the direction which public enterprise will take in the postwar era.

Citing the record of war production he asked: "Can anyone make the American people believe these things could have been accomplished by any system of prewar governmental planning and development other than our free enterprise system?"

"Woe to America," he added, "if the Government of the United States does not avail itself of the unselfish intelligent influence of its men of applied science."

Referring to the potentialities of the beneficent application of nuclear energy as an "enormous new continent," Mr. Parker urged that men be left free to mark out their own course of development under a system of free competitive enterprise.

Mr. Parker spoke of participation of engigineers in civic affairs. "No municipal undertaking," he said, "no matter how controversial, should go by without being weighed and studied by men in private and industrial life. Such studies should be made systematically by the joint organized effort of the engineering societies in the community."

Nuclear Energy Dinner

A precedent-setting dinner was held Monday evening, June 17, when the A.S.M.E. Committee on Nuclear Energy Application reported progress made since its organization in January, 1946. For the first time in the history of the Society, a member of the United States Senate addressed one of its national meetings.

Alex D. Bailey, past-president, A.S.M.E., and chairman, Committee on Nuclear Energy Application, was toastmaster. He introduced members at the speaker's table and spoke briefly about the Society's interest in nuclear energy. He explained that the purpose of the dinner meeting was to report to the Society what has been done by his committee and said that other reports of this nature could be expected in the future.

As the first speaker, Mr. Bailey introduced H. G. Bowen, honorary member A.S.M.E., rear admiral, U. S. Navy, chief, Research and Inventions, Navy Department, Washington, D. C., who spoke on "Navy's Interest in Nuclear Energy for Power Use." Admiral Bowen said that within the sphere of naval uses, the Navy hopes to take the lead in the development of nuclear power. The largest single user of power was the Navy, Admiral Bowen said, and it was also the largest single technical organization in the world. "In the Bureau of Ships," he asserted, "are many highly trained and competent power engineers who are available to develop and perfect atomic power. We would expect to do this in collaboration with the light-and-power industry and those manufacturing corporations just as we did in the case of our present marine power plants."

While competition between ordinary fuels and atomic energy as a source of power for war vessels would depend on economic considerations, military considerations today, in his opinion, justified the use of atomic power for war vessels.

Admiral Bowen described the early mechanization of the Navy and the evolution from sail to the high-pressure high-temperature steam power plants of the present fleet. He said that the Navy had not suddenly become interested in the possibility of atomic power, but was the first and for some time the only government agency actually working on some of the problems that led to the development of the atomic bomb and the possibility of atomic power.

Admiral Bowen concluded his remarks by saying, "No one can predict how our Navy will appear ten years from now. However, we shall make every effort to produce as rapidly as possible a Navy in which full consideration has been given to all possibilities: jet propulsion, gas turbines, guided missiles, pilotless aircraft, and atomic power."

Senator McMahon Addresses Society

Brien McMahon, senator from Connecticut, chairman, Joint Congressional Committee on Atomic Energy, and author of the McMahon Bill, spoke on "The Effect of the McMahon Bill on Nuclear-Energy Application."

Senator McMahon paid glowing tribute to the engineers and the engineering profession and complimented the Society on its action of expressing publicly an opinion in favor of civilian control of atomic power He explained portions of his bill affecting engineers and said that the bill would promote orderly and evolutionary development of nuclear energy for peaceful industrial purposes.

The McMahon bill establishes an Atomic Energy Commission of five civilian administrators to direct four divisions: military applications, research, production, and engineering.

"The Atomic Energy Commission," Senator McMahon said, "is required to maintain an exclusive government monopoly of facilities for the production of fissionable material. Provision is made for the operation of such facilities under management contract when it is deemed desirable. Private ownership is expressly forbidden except for facilities producing small amounts incident to research and insufficient for making an atomic bomb."

With regard to the patent provisions of his bill, Senator McMahon said that Section 11 of the bill provided that patents could be issued for all types of discoveries or inventions except solely for the production of fissionable materials or for their use for military weapons. In such cases, he asserted, the commission could make compensation to the inventor in lieu of a patent. If an invention had a dual purpose, one military and the other nonmilitary, a patent could be issued only for the nonmilitary use.

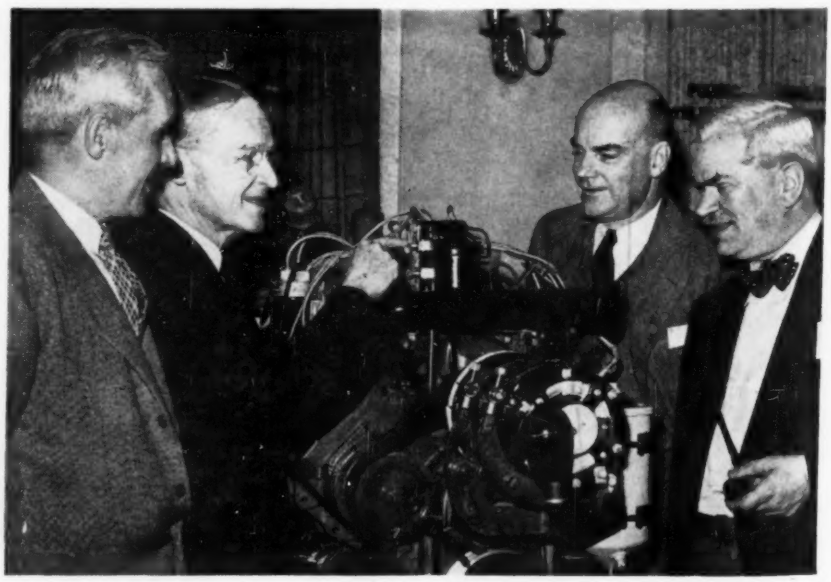
The Engineer's Viewpoint

The third speaker of the evening was A. L. Baker, general manager, The Kellex Corporation. His subject was "Mechanical and Material Problems Involved in the Beneficent Application of Nuclear Energy."

From the point of view of an engineer, Mr Baker described a nuclear-energy power plant and discussed the problems that engineers will have to solve in the development of nuclear-energy-generator process systems. He said that new high-temperature metals and refractories will have to be developed and the problems of creep and strength diminution under long-time loading will have to be faced.

Since the utilization of nuclear energy does not now permit direct conversion to electrical energy, Mr. Baker said, various types of heat-transfer problems will confront designers, and in all probability new heat-transfer fluids will have to be developed to meet the special requirements of the process.

Mr. Baker said that the A.S.M.E. had the responsibility of "planning, organizing, and executing codes as a guide in the successful de-



J. B. HAYES, PRESIDENT E.I.C., LISTENS TO DESCRIPTION OF EXHIBIT AT 1946 SEMI-ANNUAL MEETING

(*Left to right:* J. W. Armour, chairman, General Committee of the 1946 Semi-Annual Meeting, D. Robert Yarnall, president, A.S.M.E., J. W. Parker, past-president, A.S.M.E., and J. B. Hayes, president, E.I.C.

Random Shots of the 1946 Semi-Annual Meeting

[(1) Listening to a report by the secretary during the meeting of the Council, *left to right:* R. M. Gates, D. C. A. Bosworth, Arthur J. Kerr, and J. Noble Landis. (2) At the Banquet, *foreground, left to right:* Mrs. Don Kigar, Mr. Kigar, and Mrs. H. E. Bumgardner; *background, left to right:* Mrs. R. M. Van Duzer, Jr., Mr. Van Duzer, Jr., Mrs. H. E. Longmire, H. S. Walker and Mrs. Walker. (3) H. T. Woolson, *left*, and R. F. Gagg standing before the Chrysler multibank engine. (4) A.S.M.E. publications go on sale, *left to right:* C. H. Hangoe and E. A. Ratzel. (5) At the Banquet, *left to right:* E. S. Theiss, Mrs. Theiss, and A. C. Pasini. (6) *Left to right:* A. R. Stevenson, Jr., W. Julian King, and James W. Robert. (7) Fred M. Zeder, *left*, and H. T. Woolson, both of Chrysler Corporation. (8) Before the Women's Registration desk, *left to right:* Mrs. C. L. Freund, Miss Mary Freund, Mrs. C. H. Berry, Miss Teresa Van Duzer, Mrs. Paul W. Thompson, chairman, Women's Committee, and Mrs. Roscoe W. Norton. (9) Tom Jeffords, *left*, listens to W. S. Knudsen. (10) *Left to right:* W. H. Brown, Paul Piper, president, Society of Aeronautical Weight Engineers, Palmer Kalsem, and Stan Knowland. (11) At the Banquet, *left to right:* W. A. Carter, Miss Ruth Kluzak, A. K. Bak, Mrs. H. E. Macomber, *foreground*, Mr. Macomber. (12) Visitors from Canada: A. O. Adams, R.C.A.F., *left*, and G. H. Disbarats, R.C.N.]

velopment of nuclear energy." Among the codes contemplated by the A.S.M.E. Committee on Nuclear-Energy Application, Mr. Baker listed the following: (1) Safety codes for construction and operation; (2) standardization of definitions, constants, units, and symbols; (3) standard specifications for materials of construction; (4) test procedure for materials; and (5) power test codes.

Speaking for the men who participated in the Manhattan District project, Mr. Baker said, "We are humble in our thinking and know definitely that we know little about this great new field."

Air Transportation

At the general luncheon, Tuesday, June 18, J. Parker Van Zandt, director of aviation research, The Brookings Institution, Washington, D. C., spoke on "Air Transportation and World Understanding."

Mr. Van Zandt predicted a "fantastic shrinkage of the world" before the end of the present decade. The major cities of the world, he said, would be connected by a network of trunk air routes over which daily flights would operate at sustained speeds in the neighborhood of 300 miles per hour and that no place on earth would be more than two days away.

As a means of stimulating world travel, Mr. Van Zandt suggested a 3-cent fare as the goal for air transportation. Mass air travel, he said, would foster trade, create jobs, offset the dollar shortage abroad, develop backward areas, and promote world understanding.

He advocated a program of air-travel fellowships to enable teachers and others of relatively modest income to use air-transport facilities. Such travel could be accommodated during the slack hours of travel on a special "deferred passenger" basis.

Mr. Van Zandt's talk, originally given at the A.S.M.E. 1946 Spring Meeting, Chattanooga, Tenn., was published on pages 605 to 607 of the July issue of MECHANICAL ENGINEERING.

Industrial Preparedness

At the Aviation Dinner, Tuesday evening, June 18, Col. C. L. Munroe, Jr., Army Air Forces, spoke on "Air Industrial Planning in the Postwar Period." He was followed by Dean C. Smith, director of development, Fairchild Engine and Airplane Corporation, whose subject was "Impact of Industrial Mobilization on Aircraft Industry."

Colonel Munroe delivered the address written by B. W. Chidlaw, deputy commanding general, Air Materiel Command, and Mr. Smith spoke for J. Carlton Ward, Jr., president, Fairchild Engine and Airplane Corporation, who could not attend the dinner as planned.

Colonel Munroe said that two wars have shown that our war effort is like a two-sided coin, one side representing the work of the Armed Forces and the other side that of industry. While there was only limited industrial planning before World War II, the Armed Forces and industry are today very much concerned with all phases of industrial planning. He said that the "what" and the "when" of industrial planning compose the military side of the "proverbial coin," but that the "who," "where" and "how" compose the industrial side of it.

Colonel Munroe listed the four keys to air industrial planning as follows: (1) Adequate research and development program to carry through production in limited quantities to provide production proving and service testing; (2) maintenance of a healthy nucleus of an aircraft industry capable of rapid expansion and supported by a program of continuing military production; (3) assurance of an industrial reserve of production facilities and resources; and (4) program of specific industrial-preparedness plans undertaken jointly between the Air Forces and industry to maintain our newest air weapons in a state of readiness for volume production.

He said, "It is hard to realize that every plane and engine actually used in combat during the past war, and this is without exception, were designed prior to Pearl Harbor. In other words, in a total of nearly four years of war we failed to complete the cycle of design, engineering, producing, and combat-testing a single airplane. In fact the average period of design to combat-test was five to seven years, a very long period as measured by our constantly accelerating standards of research and development and by the shifting nature of international conditions."

"The Air Forces are concerned with always having an aircraft industry which will be able: first, to provide replacements of superior design and performance for our air squadrons; second, to carry on its important share in research and development of new types of aircraft required to maintain our country's leadership in aeronautics; and finally, to expand with sufficient rapidity to meet production requirements in case of an emergency."

Speaking from the point of view of industry, Mr. Smith said that war planning and industrial planning are two equal members of the same team. Using a football analogy, he compared the military to the quarterback, who must call the play, and industry to the men who must carry the ball.

"It will never again be sufficient," he said, "for industry to find out at some convenient later date what the score is and how many minutes are left to play—by that time the ball game will be all over."

Mr. Smith reviewed war production by aid of charts and said that "a necessary part of any future planning should be a study of the supply of suitable engineering talent and a preparation of plans for refresher courses and accelerated courses in educational institutions to meet the emergency needs."

While the technical significance of industrial planning is readily perceived by engineers, Mr. Smith expressed concern over the habit of peacetime lethargy that may influence our peacetime thinking and planning. He called on engineers to lead the public in an appreciation of this need.

"If the full significance of industrial mobilization does not reach the American public," he warned, "if its gospel is not spread by this and other bodies of similar nature, we have no hope of real national security now or at any future time."

Proving Ground Experience

At the general luncheon Wednesday, June 19, Edward H. Gray, lieutenant-colonel, Ordnance Research and Development Service, Aberdeen Proving Ground, Aberdeen, Md., spoke on "Ordnance Experience in Development-Testing of Tank Engines."

While Germany was ahead of the Allies in many fields of technological research, Colonel Gray said that the Nazis were unable to develop many practical reliable weapons because they lacked an adequate development-testing program.

Colonel Gray described the work of the Ordnance Proving Grounds, Aberdeen, Md., and

PRINCIPALS OF THE NOISE-CONTROL SESSION, WEDNESDAY AFTERNOON, JUNE 19
(*Left to right:* H. Hallerith, Jr., K. R. Jackson, Leo L. Bernek and F. K. Teichmann.)

Lieut. Gen. William S. Knudsen, Honorary Member, A.S.M.E.

illustrated some of the results. He said that on early tanks approximately 40 per cent of all maintenance was for engines alone, but that at the end of the war even under the severest proving-ground testing, engine maintenance averaged only 15 per cent and the maintenance of the total vehicle was greatly reduced.

Colonel Gray urged engineers not to forget the experience and the lessons of the war. "The armed forces," he said, "cannot accomplish the tremendous task of preparedness alone. The continued work and co-operation of science and industry with the military is the only way to military strength—our finest insurance for a peaceful world."

Banquet

The semi-annual banquet of the A.S.M.E. was held Wednesday evening, June 19, at the Statler Hotel. More than 400 members and guests attended.

President Yarnall, as chairman, introduced the members seated at the speakers' table and turned the meeting over to K. T. Keller, associate member A.S.M.E., and president, Chrysler Motor Corporation, who was toastmaster. Mr. Keller spoke briefly, addressing his remarks to the younger men present. He recounted some of his early experiences to show how an unfortunate incident can direct a man to channels where success can be achieved.

Lieut. Gen. William S. Knudsen, director, General Motors Corporation, and formerly director general, Office of Production Management, was presented with a certificate of honorary membership in the A.S.M.E. by President Yarnall. In response to long applause, General Knudsen spoke briefly to express appreciation for the honor conferred upon him. About war production, he said the main thing was the fact that it helped soldiers in the field.

Following the presentation, Mr. Keller introduced Jacob L. Devers, commanding general, Army Ground Forces, Washington, D. C., who spoke on "America's Security."

General Devers paid tribute to American engineers for designing the best tanks in the world. He refuted "irresponsible talk from certain quarters" and stated that "our tanks were the most reliable, the most maneuverable the best manned and the best fought of any army in the war."

With regard to the steps that the nation should take in the interest of national security, General Devers said, "(1) We must put our own house in order. (2) We must clarify and define our course of action in international affairs. (3) We must have knowledge and understanding of the nations and of their way of thinking and their motives. (4) We must work to establish a world organization. (5) We must see that our Armed Forces have the means to accomplish their missions."

General Devers was optimistic about the United Nations and world peace. Referring to the many changes necessary to perfect the Garand rifle, he said that the United Nations Council can be made to work even if it takes "200 changes" and "a war to convince some of the people" of that fact.

Imagination in Engineering

The last social function of the 1946 Semi-Annual Meeting was a luncheon on Thursday, June 20. William B. Stout, consultant, Graham Paige Motor Company, Detroit, Mich., spoke on "Imagination in Engineering." He called upon engineers to re-evaluate their basic assumptions when setting out to redesign a product. Most new things, he said, result from a mind that sees the basic assumptions in a new light. If a thing can be visualized, someone will find out how it can be done.

Mr. Stout called for "human research" among engineers. He said that if technically trained men could encourage people, and labor, and industry to think of themselves primarily as consumers instead of farmers, or workers, or bankers, a great step would be taken toward the elimination of economic minorities and the development of a force that would help to unite the nation.

1947 Semi-Annual Meeting

Following Mr. Stout's talk, President Yarnall announced that the 1947 Semi-Annual Meeting would be held in Chicago, Ill. He introduced R. H. Bacon of the A.S.M.E. Chicago Section, who expressed his delight at the selection of Chicago as the 1947 Semi-Annual Meeting city and extended an invitation to all members to accept the hospitality of his section.

President Yarnall complimented J. W. Armour, chairman, general committee of the A.S.M.E. 1946 Semi-Annual Meeting, and the various members of the subcommittees for their effort in the organization of a splendid meeting.

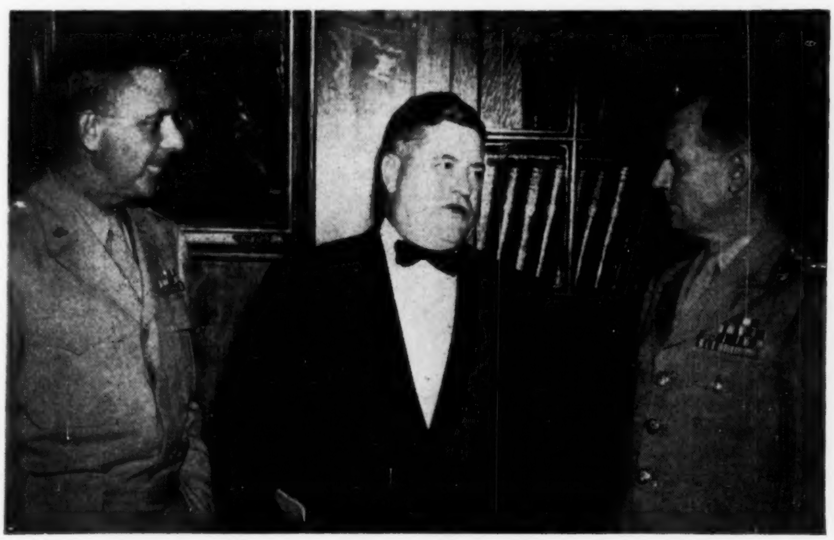
Technical Sessions

During the four days of the meeting 35 technical sessions were held during which more than 75 papers were presented. These sessions were well attended and much pertinent discussion was heard. In subsequent issues of Mechanical Engineering, Transactions, and the *Journal of Applied Mechanics* many of these papers will be published with the discussion stimulated by the paper.

The A.S.M.E. Detroit Section sponsored two sessions on the Great Lakes carriers during which four papers were presented covering design of marine power plants and design features peculiar to the Great Lakes bulk cargo type of vessel.

The Research Committees on Metal Cutting and Cutting Fluids sponsored jointly with other Divisions four sessions during which ten papers were presented. Recent work of the committees was reported.

The two Materials Handling sessions drew interested audiences. The discussion which followed was keen and to the point as the attendance was composed particularly of materials-handling engineers from large plants in the Detroit area. A resolution, introduced by F. J. Shepard, Jr., chairman, A.S.M.E. Materials Handling Division, asked that the Council of



Informal Discussion Before the Semi-Annual Banquet
(*Left to right:* J. L. Devers, K. T. Keller, and G. M. Barnes.)

the Society be asked to develop a Safety Code for Industrial Power Trucks. After discussion from the floor, this resolution was unanimously adopted.

Management Sessions

The Management (I) Session of the 1946 Semi-Annual Meeting was presided over by Prof. Charles D. Gordy, University of Michigan. The recorder was Baxter H. Webb, Civil Service Commission, Detroit, Mich. The two papers presented were, "The Development of Foremen as Department Managers," by Charles H. King, Clark Equipment Company, and "Desirable Terms for Collective Agreements From the Management's Point of View," by Albert E. Meder, firm of Beaumont, Smith, and Harris. Mr. King's paper was read by Claude Fenn, Clark Equipment Company.

Mr. King's paper discussed the procedure developed in his company for the selection and training of department heads. An outstanding point was the emphasis placed upon starting the training program in an atmosphere removed from the plant, such as at a club or a hotel. Here the group could be congregated for a period of about one week during which time they would be introduced to the problems of supervision and would have the opportunity to meet and associate with the top members of the firm. The company feels that this removal from the shop atmosphere is very significant in starting the thinking of these men as supervisors. A second point of considerable interest was that any question pertinent to the management of the business or the policies of the company which might arise in any supervisor's mind, should be answered directly by the management. Thus no secrets would be held from any supervisor from the lowest grade of supervision up.

Mr. Meder's paper excited a great deal of questioning and discussion. He stated that, "Union representatives are in general more thoroughly prepared than managers when they go into a bargaining conference." He believes that the contract should contain an article defining the prerogatives of the company. He stressed the wisdom of having a fair standard of production clause in the contract.

The Management (II) Session was presided over by Prof. John J. Uicker of the University of Detroit, with Frederick P.

GREETINGS EXCHANGED BEFORE THE POWER (II) SESSION

(*Left to right:* D. L. Perkins, recorder, Sabin Crocker, Chairman, and Shepard T. Powell, author.)

O. W. BOSTON ADDRESSES JOINT SESSION OF RESEARCH COMMITTEES ON METAL CUTTING AND CUTTING FLUIDS (III) AND PRODUCTION ENGINEERING (IV)

Van Dame of the Ready Power Company as recorder. The two papers on this program were, "Better Methods and Its Future," by Guy Bates of the General Motors Corporation and "Building Tomorrow's Leaders Today," by E. F. La Tulip of the Murray Corporation of America. In the absence of Mr. La Tulip, his paper was read by F. P. Van Dame, recorder for the session. Mr. La Tulip's paper stressed the extreme importance of the proper training of supervisors. He reminded his audience of the fact that company policies must be carried out under the direct supervision of the departmental foreman. As these departmental foremen represent the company to the labor force, too much emphasis could not be given to the training of these men in a knowledge and understanding of company policies and practices so that they could best carry out their important function as representatives of management.

Mr. Bates's paper caused considerable comment because of his graphic analysis of the ways in which better methods could be promoted in the plant and of the procedures which should be adopted by the management to make better methods seem to be the logical course of action. An important point from his paper was that better methods are a possible solution (sometimes the only available one) to the problem many firms face when manufacturing costs rise faster than the selling price. A second important point was that no justification for better methods can exist in so far as the company is concerned, unless a reduction in cost is obtained as a reward for the effort and skill put into the new development. A third point was that by taking the "mystery" out of better methods it is possible to help individuals to see ways of producing the product by short-cut methods.

Both sessions were well attended and the discussion was lively. (Reported by John C. Wicker.)

Plant Trips

More than 60 members visited the Hiram Walker Distillery, Windsor, Can., on Monday, June 17, to inspect the plant that produces the highly regarded Canadian Club whiskey and to learn more about the process of fermentation and distillation.

For many the trip was an introduction to Canada and the efficient and courteous Canadian customs authorities. As each man sounded off the state of his birth at the customs gate it became evident that the A.S.M.E. was truly a national organization.

At the distillery members were formed in small groups and separated to various parts of the plant. From the mills where the grain was ground one group passed on to the fermentation vats, the stills, and then to the aging storehouses. There was a pleasing aroma everywhere. After inspection of the bottling and packaging plant, the various groups were taken along corridors and up stairs richly decorated with polished brass into a room where the product of the plant could be properly appraised.

It was the concensus of all present that the excellence of the product was reflected in the atmosphere of the plant where it was manufactured. The ubiquitous ivy, the well-tended lawns, but mostly the quietness and cleanliness of the old buildings made the trip a memorable one.

Ford Motor Company Plant

The most popular inspection trip of the meeting was the visit to the Ford Motor Company, River Rouge, Mich., Wednesday afternoon, June 19. Five buses carried more than 140 members to the Ford Rouge Plant, the world's largest industrial city, which covers 1196 acres of blast furnaces, coke ovens, docks, assembly lines, machine and repair shops.

Although the assembly lines were not in operation, members enjoyed a profitable afternoon by devoting their tour to an inspection of the open-hearth furnaces, the rolling mills, and the Rouge Power Plant. The magnitude of the plants and the special visitors' galleries high above the operating floor, strategically placed to allow close observation of principal operations, impressed members.

The Rouge Power Plant has six turbogenerators having a total capacity of 325,000 kw, and carries the entire load of the Ford Motor

CONTROL BOARD AT THE FORD RIVER ROUGE POWER PLANT VISITED BY MEMBERS DURING THE 1946 SEMI-ANNUAL MEETING

Company River Rouge plant. Visitors commented on the immaculate layout of the plant, the chrome plating on valves and turbine-casing trimmings as well as the polished black-enamel sheathing on most of the steam equipment.

On Wednesday afternoon, June 19, a party of 23 members visited the Ex-Cell-O Corporation where a broad line of cutting tools, precision machine tools, and precision parts are manufactured. Visitors were shown the component parts of various machines in the process of manufacture and later the general asembly of the complete equipment.

Eighty members visited the 28-acre Plymouth Plant of the General Motors Corporation on Thursday afternoon, June 20. The high light of this visit was the assembly line designed for a capacity of three cars a minute. The assembly line was in operation. Members observed automobile parts arrive at one end of the plant and finished cars roll out of the other end.

Twenty members visited the U. S. Rubber Company plant on Thursday afternoon, June 20, where they watched the manufacture of tires.

Delray Plant

An inspection trip to the Delray Power Plant of The Detroit Edison Company, the largest of the four plants operated by the company, was made by 40 members, Tuesday afternoon, June 18. The trip by bus from the hotel to the plant was through the industrial section of Detroit and gave visitors a sense of the industrial activity of the city.

At the plant the visitors were taken to a conference room where Elmer Liedel, technical engineer, gave a description of the plant and commented on some of the operating problems. So many questions were asked that the meeting was almost turned into an unofficial technical session.

The tour of the plant included coal-handling facilities, turbine room, high-pressure boilers, and testing facilities. Before leaving the plant each member was given a booklet containing a full description of all facilities and an evaluation of operating experience for the first year of plant operation.

Women's Program

The Women's Committee of the A.S.M.E. Detroit Section, under the chairmanship of Mrs. Paul W. Thompson, arranged an entertaining program for the visiting members and guests of the A.S.M.E. Woman's Auxiliary.

On Sunday, June 16, the program called for a visit to the Ford Sunday Evening Hour Broadcast. The following day there was a tour of the Horace Rackham Educational Memorial. On successive days the program included luncheon at Dearborn Inn, a trip through Greenfield Village, a drive through residential Detroit, the Lake Shore and Belle Isle. On Thursday, June 20, there was a drive to Canada over the Ambassador Bridge and through scenic sections of Windsor, Ontario.

Committees

Members of the committees of the A.S.M.E. Detroit Section who worked hard to plan and organize the 1946 Semi-Annual Meeting were:

General Committee: J. W. Armour, chairman, A. C. Pasini, secretary, J. M. Geisinger, assistant secretary, H. S. Walker, treasurer, B. W. Beyer, vice-chairman, C. J. Freund, vice-chairman, Tom Jeffords, vice-chairman, R. K. Weldy, vice-chairman and chairman of the subcommittees.

Representing the Engineering Institute of Canada: A. D. Harris, chairman, J. A. Hoba, J. K. Ronson, G. W. Lusby, and F. J. Ryder, chairman, Border Cities Branch, ex-officio.

Technical Sessions: A. W. Honywill, chairman, J. J. Uicker, secretary, C. R. Alden, R. L. Beers, M. W. Benjamin, Jesse M. Campbell, J. M. Campbell, Sabin Crocker, C. W. Good, L. T. Knocke, F. W. Lucht, and D. L. Perkins.

Inspection Trips: R. H. Stellwagen, chairman, R. F. Hanson, vice-chairman, Ralph Brisco, W. W. Dulmage, F. T. Harrington, K. R. Herman, D. E. Jahncke, H. E. Macomber, Barney Platt, G. C. Richards, P. R. Voght, B. H. Webb, and H. T. Woolson.

Registration: H. K. Gandelot, chairman, R. M. Van Duzer, vice-chairman, A. R. Borden, F. L. Donaher, C. H. Grinell, F. J. Linsenmeyer, L. H. Nagler, E. B. Rall, E. F. Riesing, J. M. Riordan, G. J. Scranton, Miss Jerry Lashley, Miss A. J. Maclom, Miss Mary McGillis, and Miss Priscilla Powers.

Reception: O. A. Soderberg, chairman, W. A. Carter, L. Carmondy, H. B. Dirks, W. P. Thomas, H. L. Walton, and A. E. White.

Entertainment: M. W. Benjamin, chairman, J. W. Brennan, I. N. Cuthbert, C. M. Drake, B. W. Lane, L. R. Leatherman, John Rosebrough, and Vernon Schafer.

Student Group: D. E. Jahncke, chairman, Hubert McAulay, Harold McGregor, Jr., Victor Rykwalder, and Hurst Wulf.

Hotel: T. E. Winkler, chairman, H. D. Chappell, H. S. Ford, F. T. Harrington, J. F. Hirshfeld, J. E. Livingstone, D. E. Newkirk, G. Stewart, and P. A. Van der Meer.

Print and Signs: J. H. Spurgeon, chairman, R. J. Brandon, assistant-chairman, F. Boddy, J. A. Martin, Hubert McAulay, and Victor Rykwalder.

Publicity: H. E. Bumgardner, chairman, E. J. Abbott, W. B. Hurley, J. F. Jarnagin, E. P. Lovejoy, and John Rosebrough.

Women's Committee: Mrs. Paul W. Thompson, chairman, Mrs. Clement J. Freund, vice-chairman, Mrs. Robert M. Van Duzer, Jr., vice-chairman, Mrs. F. D. Campbell, secretary, Mrs. James W. Armour, Mrs. Ben W. Beyer, Jr., Mrs. Walter D. Drysdale, Mrs. Howard K. Gandelot, Mrs. Thomas W. Jeffords, Miss Ruth G. Kluzak, Mrs. Harry E. Longmire,

A.S.M.E. AND E.I.C. VISITORS AT THE HIRAM WALKER DISTILLERY, WINDSOR, CANADA

Mrs. H. E. Macomber, Mrs. Edwin Rall, Mrs. Louis J. Schrenk, Mrs. Harvey A. Wagner, Mrs. Henry S. Walker, Mrs. J. Herbert Walker, Mrs. Baxter H. Webb, and Mrs. R. K. Weldy.

Engineering Institute of Canada Woman's Committee: Mrs. C. G. R. Armstrong, chairman, Mrs. A. D. Harris, Mrs. G. G. Henderson, and Mrs. F. J. Ryder.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held at Detroit, Mich., June 16, 1946

A MEETING of the Executive Committee of the Council was held in the Book-Cadillac Hotel, Detroit, Mich., June 16, 1946. There were present: D. Robert Yarnall, president; R. F. Gagg, J. N. Landis, A. R. Stevenson, Jr., vice-presidents; K. W. Jappe, treasurer; Alex D. Bailey, H. V. Coes, David Larkin, James M. Robert, members of the Council; A. R. Mumford (Sections); C. E. Davies, secretary; and George A. Stetson, editor.

Honors and Awards

Upon recommendation of the Board of Honors and Awards, it was voted to approve the following awards for 1946:

Holley Medal to Norman Rothwell Gibson, vice-president, Buffalo Niagara Electric Corporation, Buffalo, N. Y., "for achievements and inventions which have advanced the sciences of hydraulics and hydromechanics, including an original method of water measurement which made possible more accurate testing of large hydroelectric generating units."

Melville Prize Medal for Original Work, to Troels Warming, Diesel engineering division, Harnischfeger Corporation, Port Washington, Wis., for his paper, "Polar Diagrams for Tuning of Exhaust Pipes."

Junior Award to Martin Goland, chairman, engineering mechanics research, Midwest Research Institute, Kansas City, Mo., for his paper, "The Flutter of a Uniform Cantilever Wing."

Standardization

Upon recommendation of the Committee on Standardization the following standards were approved as standards of the Society and for transmission to the American Standards Association for approval as A.S.A. standards: Involute Splines (revision); Milling-Cutter Teeth; and Brass or Bronze Screwed Fittings.

Research on Furnace Performance Factors

Upon recommendation of the Research Committee, approval was voted of the renewal for one year of the co-operative agreement between the U. S. Department of the Interior and the Society, which covers an investigation of ash and slag in boiler furnaces and the external corrosion of furnace wall tubes.

1946 Boiler Code Revisions

It was voted to confirm letter-ballot approval of the 1946 Revisions and Addenda to the A.S.M.E. Boiler Construction Code as standard practice of the Society.

R. L. Sackett

The resignation of Dean R. L. Sackett because of poor health was noted with deep regret and it was voted to send Dean Sackett an expression of the sincere gratitude of the Society for his long and useful service.

Planning Committee of the U.E.T.

Approval was voted of the appointment of the Secretary to the Planning Committee for an Engineering Societies Building, organized by the United Engineering Trustees, Inc.

Vermilye Medal

It was noted that the Advisory Committee for the Vermilye Medal, established in 1938 by The Franklin Institute as an award for recognition of outstanding contributions in the field of industrial management, had been abandoned.

Appointments

The following appointments were confirmed: Col. Theodore A. Weyher, honorary vice-president, to serve as A.S.M.E. representative to the Society of Civil Engineers of France, Conference of Representatives of Engineering Societies, Paris, June 21–22, 1946.

C. W. DeForest and Walker L. Cisler, honorary vice-presidents, to serve as A.S.M.E. representatives to the International Conference on Large High-Tension Systems, Paris, June 27 to July 6, 1946.

1946 Semi-Annual Business Meeting, A.S.M.E.

THE 1946 Semi-Annual Business Meeting of The American Society of Mechanical Engineers was held at the Statler Hotel, Detroit, Mich., on June 17, 1946. D. Robert Yarnall, president of the Society, presided.

C. E. Davies, secretary A.S.M.E., announced that the 1947 Semi-Annual Meeting of the Society would be held in Chicago, Ill., June 15–20, 1947.

Approval was voted of the personnel selected to constitute the Nominating Committee for 1947, as follows:

REGION I

W. K. Simpson, 9 Sands St., Waterbury 30, Conn.

L. J. Hooper, *First Alternate,* Worcester Polytechnic Institute, Worcester, Mass.

L. C. Smith, *Second Alternate,* Spencer Turbine Company, Hartford, Conn.

James A. Powell, *Third Alternate,* Stone and Webster Engineering Corporation, 49 Federal St., Boston 7, Mass.

REGION II

J. H. Sengstaken, Western Precipitation Corporation, 405 Lexington Ave., New York, N. Y.

R. W. Flynn, *First Alternate,* Gulf Oil Company, 17 Battery Place, New York 4, N. Y.

Harold C. R. Carlson, *Second Alternate,* Lee Spring Company, Inc., 30 Main St., Brooklyn 1. N. Y.

REGION III

R. C. Dannettel, Consolidated Gas Electric Light and Power Company, Baltimore, Md.

F. S. Erdman, *First Alternate,* College of Engineering, Cornell University, Ithaca, N. Y.

P. C. Osterman, *Second Alternate,* American Gas Furnace Company, Spring and Lafayette Sts., Elizabeth, N. J.

REGION IV

J. B. Jones, Virginia Polytechnic Institute, Blacksburg, Va.

Paul R. Yopp, *First Alternate,* Babcock and Wilcox Company, 1203 Candler Building, Atlanta 3, Ga.

J. Mack Tucker, *Second Alternate,* University of Tennessee, Knoxville, Tenn.

REGION V

F. H. Vose, Case School of Applied Science, 10900 Euclid Ave., Cleveland 6, Ohio

J. G. Martin, *First Alternate,* Babcock and Wilcox Company, 2511 Carew Tower, Cincinnati, Ohio

M. R. Bowerman, *Second Alternate,* Homeworth, Ohio.

REGION VI

Huber O. Croft, University of Iowa, 122 Engineering Building, Iowa City, Iowa

R. W. Merkle, *First Alternate,* 112 Springer Ave., Edwardsville, Ill.

C. F. Moulton, *Second Alternate,* Nebraska Power Company, 4th and Jones St., Omaha, Neb.

REGION VII

Ray G. Roshong, 511 W. Pico Boulevard, Los Angeles 15, Calif.

H. C. Prescott, *First Alternate,* Golden State Company, 425 Battery St., San Francisco, Calif.

Ivan A. Shirk, *Second Alternate,* 231 Waverly Place, Spokane 13, Wash.

REGION VIII

L. J. Cucullu, New Orleans Public Service, Inc., 317 Baronne St., New Orleans 9, La.

O. L. Lewis, *First Alternate,* 818 N. Gary St., Tulsa 4, Okla.

G. H. Woelbing, *Second Alternate,* Silver Engineering Works, Inc., 3309 Blake St., Denver, Colo.

Actions of the A.S.M.E. Council

At Meetings Held at Detroit, June 16 and 17, 1946

THE Council of The American Society of Mechanical Engineers met in three sessions during the 1946 Semi-Annual Meeting at the Book-Cadillac and Statler Hotels, Detroit, Mich., June 16 and 17.

Present at all or some of these sessions were: D. Robert Yarnall, president; Alex D. Bailey, Harold V. Coes, R. M. Gates, William A. Hanley, and James M. Parker, past-presidents; Samuel R. Beitler, J. Calvin Brown, Alton C. Chick, Rudolph F. Gagg, Linn Helander, Thomas S. McEwan, A. R. Stevenson, Jr., and Edward E. Williams, vice-presidents; Samuel H. Graff, Edgar J. Kates, Arthur J. Kerr, J. Noble Landis, David Larkin, and James M. Robert, directors at large; K. W. Jappe, treasurer; A. M. Gompf (Constitution and By-Laws); R. A. North (Meetings and Program); W. M. Sheehan (Membership Development); Huber O. Croft (Nominating); L. N. Rowley, Jr., (Publications); Herman Weisberg (Research); J. A. Keeth, S. D. Moxley, A. R. Mumford (Sections); A. C. Pasini (Detroit Section chairman); R. P. Reece and Herbert Kuenzal (Relations With Colleges); D. E. Jahncke, Harold McGregor, Jr., John Rosebrough, and R. W. Wayman (junior observers); M. M. Clayton, Carl Eckhardt, Jr., J. C. Marshall, R. J. Mees, J. C. Reed, and E. S. Theiss (delegates); R. H. Phelps (librarian, Engineering Societies Library); James H. Herron, Roscoe W. Morton, and Elliott H. Whitlock (former Council members); W. L. Edel, C. Z. Gillivan, and A. O. White, (members of the Society); C. E. Davies, secretary; Ernest Hartford, executive assistant secretary; George A. Stetson, editor; D. C. A. Bosworth, comptroller; O. B. Schier, II, meetings and divisions assistant; and Alfred F. Bochenek, editorial department.

The following actions were of general interest:

Engineering Societies Library

Ralph H. Phelps, acting director, Engineering Societies Library, spoke briefly of the work of the Library and its efforts to extend its usefulness to members of the supporting societies.

Engineers Joint Council

On June 6 the Engineers Joint Council received the report of its Committee on Economic Status of the Engineer with endorsement in principle and referred the report to the constituent societies. President Yarnall and Secretary Davies discussed the report with the Regional Delegates Conference on June 15, which approved the report with slight modifications. On June 16 the Executive Committee of the Council considered the report and modifications and recommended the Council's approval. The Council endorsed the report and recommended prompt action by E. J. C. to make it effective. The report will be published in a later issue.

It was reported that the Engineers Joint Council had discussed a program for 1947 and a method of financing, had adopted the program, and had submitted it to the constituent societies for approval. It was planned to institute an educational program on E. J. C. in advance of the launching in the fall of the financial campaign. The proposed program had been described to the Regional Delegates Conference by the President and the Secretary on June 15 and the Conference had endorsed it, with some suggestions, and had recommended liberal support by members of the Society. On June 16 the Executive Committee of the Council had considered the program and had recommended that the Council endorse it and the proposed method of financing it, which the Council voted to do. Details of the plan will be published in a later issue.

COMBINED ANALYSIS OF EXPENDITURE BUDGET

	Under Committee Supervision			Printing and distribution	Office expense	Totals
	Joint bodies	Members travel	Others			
PUBLICATIONS, STANDARDS, CODES AND RESEARCH						($425,681)
1 MECHANICAL ENGINEERING, text pages	...		...	$ 36,000	$ 22,165	58,165
2 MECHANICAL ENGINEERING, advertising pages	...		...	56,800	57,174	113,974
3 Transactions and *Journal of Applied Mechanics*	...	...	$ 200	45,200	15,510	60,910
3 (a) Membership list	...	...	...	10,000	1,380	11,380
4 Mechanical catalog	...	...	...	37,000	40,533	77,533
5 Publication Sales (except Standards, Codes and Research Reports)	...	...	...	7,200	7,174	14,374
6 Standards and Codes	$ 1,000	...	...	32,300	35,104	68,404
7 Research	...	...	...	5,000	15,941	20,941
GENERAL SOCIETY ACTIVITIES						(149,202)
1 Society Meetings and publicity	...	...	20,000	....	12,802	32,802
2 Sections	...	$ 9,000	37,500	....	13,769	60,269
3 Professional Divisions	...	...	4,500	....	12,691	17,191
4 Student Branches (including Student copies of MECHANICAL ENGINEERING)	...	2,500	6,000	5,000	7,066	20,566
5 Admissions	...	...	...	....	16,645	16,645
6 Awards	...	...	1,135	....	594	1,729
GENERAL SOCIETY ADMINISTRATION						(38,625)
1 Council	...	5,800	500	....	..	6,300
2 Membership Development	...	...	2,500	....	400	2,900
3 Professional services	...	...	2,850	....	....	2,850
4 Nominating Committee	...	2,375	...	....	....	2,375
5 Retirement Fund	...	...	23,700	....	....	23,700
6 Know Your Society and Organization Charts	...	...	500	....	...	500
JOINT ACTIVITIES						($ 15,745)
1 Engineering Societies Library	$10,745	...	...	....	....	10,745
2 E.C.P.D.	1,700	...	...	....	....	1,700
3 Engineers Joint Council	800	...	...	....	....	800
4 Engineering Societies Personnel Service, Inc. (Reserve)	2,000	...	...	....	....	2,000
5 Registration (National Council of State Boards of Engineering Examiners)	500	...	...	....	....	500
INDIRECT EXPENSES						(145,295)
1 Secretary's office	...	...	...	....	$ 28,695	28,695
2 Accounting department	...	...	...	....	27,795	27,795
3 General service	...	...	...	....	51,957	51,957
4 General office	...	...	...	....	36,848	36,848
	$16,745	$19,675	$99,385	$234,500	$404,243	$774,548
Supplementary action of the Council—see minutes (item #237) of meeting, June 16, 1946	.	..	...	....	....	18,000
						$792,548

Budget for 1946–1947

The budget for 1946–1947 was presented and approved. A summary of the budget appears on page 755 of this issue.

Regional Delegates Conference

E. S. Theiss, speaker, and J. C. Reed, vice-speaker of the 1946 Regional Delegates Conference, outlined the results of the deliberations of the Conference. Detailed actions will be referred to the appropriate Society committees for recommendations to the Council. The Council voted its appreciation of the helpful and constructive work of the Conference.

Committee Reorganization

Article B6A and proposed changes in B8, Par. 7, B10, Pars. 3-6, and B11, Par. 9, of the By-Laws of the Society relating to committees, were received for first reading, approval was voted of a form of committee organization, and authorization was voted of necessary preliminary steps to put the plan into effect at the 1946 Annual Meeting.

Sections

Because the Society's regional vice-presidents have taken over many of the activities of the Committee on Sections, it was voted to relieve this committee of its responsibilities with the understanding that the present members will remain in an advisory capacity to the vice-presidents until December, 1947.

1947 National Meetings

The Council voted to hold the following national meetings in 1947: Spring Meeting, Tulsa, Okla.; Semi-Annual Meeting, Chicago, Ill.; Fall Meeting, Salt Lake City, Utah.

Theme for Society Meetings

Richard A. North, chairman of the Committee on Meetings and Program, announced that the general theme for Society meetings for the next year, at least, would be "The Public Responsibility of the Engineer."

Student Branches

The responsibility for supervising the work of the Student Branches, assigned in the By-Laws to the vice-presidents and the Committee on Relations With Colleges, was discussed. The results desired are to give the responsibility to the vice-presidents, to utilize the experience of the present Committee on Relations With Colleges, and to provide each vice-president with assistants skilled in student-branch activities. Recommendations toward these ends, presented by a committee of vice-presidents, were adopted by the Council.

Changes in the By-Laws

Because the Standing Committees on Sections and Relations With Colleges are being dropped certain changes in the By-Laws covering new procedures were received for first reading.

Honorary Members Elected

On recommendation of the Board of Honors and Awards the following persons were elected Honorary Members of the Society: Alexander G. Christie, Baltimore, Md., Ralph E. Flanders, Springfield, Vt., Irving E. Moultrop, Boston, Mass., and Lewis K. Sillcox, Watertown, N. Y.

Boiler Inspectors Hold National Meeting in Montreal, Que., Can. June 25 to 27, 1946

THE Sixteenth General Meeting of the National Board of Boiler and Pressure Vessel Inspectors was held at Hotel Windsor, Montreal, Quebec, Can., June 25 to 27, 1946.

The meeting was devoted to discussion of technical and administrative problems connected with enforcement of the regulations governing the construction, installation, and safe operation of boilers and unfired pressure vessels.

Province of Quebec Host

During the three-day meeting, which included a cruise down the St. Lawrence River, more than 100 representitives of government and municipal law-enforcement agencies, boiler and pressure-vessel manufacturers, and insurance companies, both in the United States and Canada, enjoyed the hospitality of the Province of Quebec.

Theodore Reynolds, examiner and chief inspector, Province of Quebec, was official representative of the Province of Quebec.

The meeting was presided over by Gerald Gearon, deputy chief inspector, Chicago, Ill., and chairman, National Board of Boiler and Pressure Vessel Inspectors. The program was under supervision of C. O. Myers, secretary-treasurer, National Board and member A.S.M.E. Boiler Code Committee. Addresses of welcome were made by Mr. Reynolds and the Honorable J. H. DeLisle, minister of the crown, Province of Quebec, and James O. Maher, joint deputy minister of labor, Province of Quebec. Other featured speakers were Hector S. Beaupre, director, Montreal Technical School; L. T. Gregg, chief engineer and secretary, Boiler Inspection and Insurance Company of Canada; Hugh McCulloch, president, power boiler section Canadian Steel Boiler Institute; S. Wahl, head engineer, Dominion Bridge Company Limited; N. S. Walsh, deputy minister of labor, Province of Quebec; and H. B. Oatley, chairman A.S.M.E. Boiler Code Committee.

The National Board of Boiler and Pressure Vessel Inspectors is composed of chief boiler inspectors of the states and cities of the United States and the provinces of Canada, which have adopted one or more sections of the A.S.M.E. Boiler Construction Code. One of the primary purposes of the National Board is to promote uniformity in the application of the code.

Dr. Shields Attends

J. W. Shields, secretary, A.S.M.E. Boiler Code Committee, attended the meeting as an A.S.M.E. representative.

It was announced at the meeting that Los Angeles, Calif., extended a formal invitation to the National Board to hold its Seventeenth General Meeting in that city in 1947.

Howard Coonley Addresses Convention of Chinese Engineers

AN encouraging future for China as an industrial nation was predicted by Howard Coonley, honorary vice-president for China, A.S.M.E., and formerly deputy adviser of the Chinese War Production Board. Mr. Coonley spoke at the annual banquet of the America Section of the Chinese Institute of Engineers held at the Hotel New Yorker, New York, N. Y., July 1, 1946.

Basing his remarks on his experience with the Chinese War Production Board, Mr. Coonley described the courage and perseverance of the Chinese, their eagerness for education, and the progressive point of view of their leaders. "I am convinced," he stated, "that no nation could be trained to the arts of efficient production more quickly than the Chinese."

Mr. Coonley spoke frankly as a friend of China, saying that there was "a lack of understanding of sound organization and efficient management" in China and that this was unfortunately true of "government-owned utilities as well as of the privately owned ones."

Mr. Coonley advised the Chinese engineers to set up management associations for the advancement and dissemination of information on management techniques. He announced that he had obtained a special grant of money to finance the sending of an American management specialist to assist the Chinese in organizing organizations of this type.

By working together as partners for the next few generations, Mr. Coonley expressed the opinion that Americans and Chinese could make China a dominant influence in the Far East and one of the bulwarks of world peace.

S.P.E.E. Becomes A.S.E.E.

AT the fifty-fourth annual meeting of the Society for the Promotion of Engineering Education, held at St. Louis, Mo., June 20–23, 1946, Huber O. Croft, manager A.S.M.E., 1940–1943, head of the department of mechanical engineering, University of Iowa, Iowa City, Ia., was elected president; and Robert E. Doherty, fellow A.S.M.E., president, Carnegie Institute of Technology, Pittsburgh, Pa., was awarded the Lamme Medal.

A new constitution was adopted and the name of the society was changed to American Society for Engineering Education (A.S.E.E.).

Eugene W. O'Brien

Nominated for President

A.S.M.E. OFFICERS *Nominated for* 1946–1947

DURING the Meeting of The American Society of Mechanical Engineers in Detroit, Mich., June 17–20, 1946, Eugene W. O'Brien, vice-president of the W. R. C. Smith Publishing Company, Atlanta, Ga., was nominated by the National Nominating Committee for the office of President of the Society for the year 1946–1947.

Regional Vice-Presidents named by the Committee to serve two-year terms on the Council of the A.S.M.E. were A. R. Mumford, New York, N. Y., Edward E. Williams, Charlotte, N. C. (renomination), Thomas S. McEwan, Chicago, Ill., (renomination), and Linn Helander, Manhattan, Kan. (renomination).

Regional Vice-President named by the Committee to serve a one-year term on the Council of the A.S.M.E. was Alton C. Chick, Providence, R. I. (renomination).

Directors-at-Large named by the Committee to serve four-year terms on the Council were Frederick Steele Blackall, Jr., Woonsocket, R. I., and B. V. E. Nordberg, Milwaukee, Wis.

Directors-at-Large named by the Committee to serve two-year terms on the Council were L. F. Moody, Princeton, N. J., and W. A. Carter, Detroit, Mich.

Members of the Committee making the nominations were: J. W. Zeller, Boston, Mass., representing Group I; H. E. Martin, New York, N. Y., chairman, representing Group II; A. R. Smith, Schenectady, N. Y., representing Group III; P. R. Yopp, Atlanta, Ga., representing Group IV; E. J. Martin, Ivorydale, Ohio, representing Group V; W. W. Babcock, Peoria, Ill., secretary, representing Group VI; Ralph L. Dyer, Seattle, Wash., representing Group VII; and H. R. Hughes, Jr., Dallas, Tex., representing Group VIII.

Election of A.S.M.E. officers for 1946–1947 will be held by letter ballot of the entire membership, closing September 24, 1946.

Biographical sketches of the nominees follow on the succeeding pages.

Nominated for President

Eugene William O'Brien

EUGENE WILLIAM O'BRIEN, who has been nominated to serve for one year as President of The American Society of Mechanical Engineers, was born at West Warwick, R. I., June 20, 1897.

His early education was received in the public schools of his home town. Later he entered Brown University, from which he was graduated in 1919 with the degree of B.S. in electrical engineering. Two years later the degree of Sc.M. in mechanical engineering was conferred upon him by the same university; and in 1925 the degree of M.E. by Yale University.

From 1918 to 1922 he was a member of the engineering faculty at Brown University, leaving to accept a similar position at the Sheffield Scientific School, Yale University. During his period of service as college instructor, he spent much of his time in consulting engineering, serving part time in a number of consulting offices in New England, and undertaking independent commissions in the fields of mechanical, electrical, and power design and construction.

From 1925 to 1927 he served as mechanical and electrical engineer for Jenks & Ballou, engineers, Providence, R. I., in charge of design, construction, and plant-management projects.

In 1927 Mr. O'Brien became editor in chief of the *Southern Power Journal*, and in 1933 was appointed managing director of *Southern Power Journal;* later *Southern Power and Industry*. He has been vice-president and director of W. R. C. Smith Publishing Company, Atlanta, Ga., since 1936.

He became a member of the A.S.M.E. in 1921, and served as manager in 1931–1934, and as vice-president 1934–1936, as well as on many committees of the Society. He is also a member of the American Institute of Electrical Engineers and chairman of their national Committee on Student Branches, The Newcomen Society of England, Society for the Promotion of Engineering Education, Pi Tau Sigma, Tau Beta Pi, and Sigma Xi. He served as engineering consultant to the War Production Board and War Manpower Commission.

He is also chairman of the Fulton County (Atlanta) Planning and Zoning Commission, director of the Atlanta Athletic Club, East Lake Country Club; national director of the American Society of Planning Officials; charter member of the Georgia Engineering Society, and member of the Society of American Military Engineers. He has been a frequent contributor to the technical and business press.

Nominated for Regional Vice-Presidents

To Serve Two-Year Terms

A. R. MUMFORD

LINN HELANDER

T. S. MC EWAN

EDWARD E. WILLIAMS

Albert Russell Mumford

ALBERT RUSSELL MUMFORD, who has been nominated from Region II to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born in Boston, Mass., July 13, 1895. He was graduated from the Massachusetts Institute of Technology in 1918 with the degree of B.S. in electrochemical engineering. In April, 1918, he enlisted in the U. S. Naval Reserve Forces and was assigned to work in the Construction Division at the Charleston Navy Yard. After the Armistice he became a junior marine engineer with the U. S. Shipping Board, and later was licensed as 2nd assistant engineer. While with the Shipping Board he had charge of a group of petty officers sent to Erie, Pa., to co-operate with the U. S. Bureau of Mines on the testing of the Emergency Fleet Corporation's water-tube boiler.

In March, 1919, Mr. Mumford became assistant fuel engineer of the U. S. Bureau of Mines at Pittsburgh, Pa., under Henry Kreisinger, and remained there until May, 1923. During this period extensive investigations of the use of fuel in marine water-tube and fire-tube boilers was carried on. In May, 1923, Mr. Mumford became research and design engineer for the New York Steam Corporation and remained until October, 1938. During this period studies of combustion of anthracite on chain-grate stokers were made. The Kips Bay Station of the New York Steam Corporation was designed and built during this period. In October, 1938, he became associate director of research for the Consolidated Edison Company of New York and was with that company until February, 1942. During this period research was continued on the problems of steam utility, and new projects on heat absorption in furnaces undertaken. In February of that year he became development engineer for Combustion Engineering Company, Inc., New York, N. Y., which position he now holds.

Mr. Mumford became a junior member of the A.S.M.E. in 1919 and passed successively through the grades of associate member and member to the Fellow grade and Life Member in 1942. He has served on the Program and Executive Committees of the Metropolitan Section of which he was chairman in 1940–1941. He was chairman of the Executive Committees

of the Fuels Division, and Library Board, and served as secretary of the National Nominating Committee. He was speaker at the Group Delegates Conference in 1941, chairman of the Special Research Committee on Furnace Performance Factors since 1941, and has been a member of the Committee on Sections since 1942. He has been a member and chairman of several technical and administrative committees of the National District Heating Association, and chairman of the Technical Advisory Committee on Corrosion of the American Society of Heating and Ventilating Engineers. He was a member of Committee D-5 of the American Society for Testing Materials. He is a Fellow of the American Association for the Advancement of Science. Mr. Mumford served as vice-president of the Board of Education in Bogota, N. J.

He has contributed many papers and discussions to the technical literature through the Bureau of Mines, the A.S.M.E., the N.D.H.A., the A.S.H.&V.E., and through the technical press.

Linn Helander

LINN HELANDER, who has been renominated from Region VIII to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, is professor of mechanical engineering and head of the department of mechanical engineering of Kansas State College. He served as Manager of the Society from 1939 to 1942 and as a member of the executive committee of the Kansas City Section of the Society from 1935 to 1939. He was vice-chairman of the Kansas City Section for the fiscal year 1936–1937 and chairman for the fiscal year 1937–1938. In 1944 he again served as a member of the Section's executive committee. Since 1941 he has been an advisory member of the Society's Committee on Education and Training for Industry. He was chairman of the Semi-Annual Meeting of the Society held in Kansas City in 1941 From 1936 to 1938 he was honorary chairman of the Kansas State College Student Branch of the A.S.M.E., and in 1944 he again served in that capacity. In 1936 he served as a delegate from Kansas State College to the Third World Power Conference, Washington, D. C., and from 1936 to 1938 as a member of the executive committee of the Kansas Engineering Society.

Professor Helander was born in Chicago, Ill., August 28, 1891, and was graduated from the Yeatmen High School in St. Louis in 1910 and from the University of Illinois in 1915 with the degree of B.S. in mechanical engineering.

For a brief period after graduation Professor Helander worked as a member of a group investigating stresses in railroad rails, under the direction of Prof. A. N. Talbot, and then entered the employ of the Pittsburgh Crucible Steel Company, Midland, Pa., as a steam engineer. From 1917 to 1918 he was on the editorial staff of the *Iron Age*, and from 1918 to 1919 he was assistant engineer of tests, Ordnance Department, U. S. Army, with supervisory responsibilities in the Montreal District. In 1919 he became a general engineer with the Westinghouse Electric and Manufacturing Company, where he made extensive studies of the use of regenerative feedwater heating, higher pressures and temperatures, and reheating.

From 1925 to 1929 Professor Helander was a senior engineer with the U.G.I. Contracting Company, Philadelphia, Pa., now United Engineers and Constructors, and from 1929 to 1931 was employed first by the Westinghouse Company on a special assignment, and then by the Champion Fibre Company as a consultant. In 1931 he became assistant professor of mechanical engineering at the University of Pittsburgh and in 1935 was appointed to his present position of professor and head of the department of mechanical engineering at Kansas State College. From 1933 to 1935 he was engaged in private practice in Chicago as a consulting and research engineer.

Professor Helander joined the A.S.M.E. as a junior in 1916 and became a full member in 1924. He is a member of The Franklin Institute, American Association for the Advancement of Science, American Academy of Political and Social Science, Kansas Engineering Society, The Newcomen Society of England, Society for the Promotion of Engineering Education, Sigma Xi, Tau Beta Pi, Phi Kappa Phi, and Pi Tau Sigma.

Professor Helander has contributed widely to the technical literature on subjects related to economic and thermodynamic factors in steam-power generation. He was co-ordinator for the National Fuel Efficiency Program in the Manhattan, Kan., area during the war.

Thomas S. McEwan

THOMAS SPRING McEWAN, consulting management engineer of Chicago, Ill., who has been renominated from Region VI to serve two years as Regional Vice-President of The American Society of Mechanical Engineers, was born on April 1, 1889, in Jersey City, N. J. After the usual education in grade and high schools, he entered Cornell University from which he was graduated in 1911 with the degree in mechanical engineering.

His first position was as engineer in the West Lynn, Mass., plant of the General Electric Company. In 1915 he became assistant sales manager of the SKF Industries Inc., being stationed in New York, N. Y., and Hartford, Conn. When the United States declared war in 1917, he saw serviceas Second Lieutenant in the Aviation Section, S.R.C., U. S. Army. Upon his discharge from the Army, he accepted a position as Chicago district sales manager with the Cowan Truck Division, Yale & Towne Manufacturing Company.

In 1925 Mr. McEwan joined the Haynes Corporation, Chicago, Ill., as a consulting management engineer and senior vice-president. In 1933 he became connected with Stevenson, Jordan and Harrison, New York and Chicago, becoming Midwest resident manager-engineer for seven years. His work throughout the Middle West has covered all phases of management and engineering. From 1940 and subsequent to his government job, he continued with this type of work as vice-president of McClure, Hadden, and Ortman, Inc., Chicago, Ill.

Because of his extensive knowledge of the facilities, equipment, and personnel possessed by plants throughout the Chicago area, Mr. McEwan, early in 1941, was selected to set up and head the War Production Board in the Seventh Federal Reserve District as regional Director, with headquarters in Chicago.

He has been a member of the A.S.M.E. since 1915. Despite the many duties in connection with his professional work, Mr. McEwan has found time to take part in the activities of the Chicago Section, serving as chairman for three years, 1936–1938.

In 1943 he helped organize the Chicago Technical Societies Council, of which he was president for two years. He is also a past-president of the Cornell University Club of Chicago.

Edward E. Williams

EDWARD E. WILLIAMS, renominated from Region IV to serve for two years as Regional Vice-President of The American Society of Mechanical Engineers, was born at Birmingham, Ala., March 25, 1892. He attended Birmingham High School, and graduated from the Georgia School of Technology in 1914, with the degree of B.S. in electrical engineering.

He was employed in the student engineering department of the General Electric Company, Schenectady, N. Y., from July 15, 1915, until March 15, 1920. He resigned to accept the position of municipal superintendent with the Water and Light Commission, Greenville, N. C., in charge of municipal utilities. He resigned this position on April 1, 1924, to become general superintendent of steam plants of the Southern Power Company, now the Duke Power Company, in charge of operation and maintenance of steam-electric generating stations of the Duke Power System in the Piedmont Section of North and South Carolina, which position he holds at the present time.

Mr. Williams has been a member of the A.S.M.E. since 1924. He was chairman of the Charlotte Section, now Piedmont Section, in 1928. He has served on various A.S.M.E. Committees and has been active in North Carolina Sections and Student Branches. He was appointed Manager of the Society on June 18, 1945, and elected Regional Vice-President in September, 1945. He is a member of the North Carolina Society of Engineers, past-president of the Charlotte Engineers Club, and an honorary member of Pi Tau Sigma Honorary Mechanical Engineering fraternity. He became a registered engineer, State of North Carolina, in 1924.

Nominated for Regional Vice-President

To Serve One-Year Term

Alton C. Chick

ALTON C. CHICK

ALTON C. CHICK, who has been renominated from Region I to serve one year as Regional Vice-President of The American Society of Mechanical Engineers, was born in Limerick, Me., October 26, 1896. He received his B.S. degree in mechanical engineering from Brown University in 1919 and his M.S. degree in civil engineering in 1926.

During his junior year at Brown University, Mr. Chick enlisted in the U. S. Navy. He was placed on inactive duty to attend a ten weeks' course in mechanical engineering at Brown University thus completing his senior year's work in that time. After this course, he was assigned to the U. S. Navy Steam Engineering School, Stevens Institute of Technology, Hoboken, N. J., from which he was commissioned an Ensign, and assigned to sea duty on the naval transport *U.S.S. Montpelier*. In June, 1919, he was honorably discharged from the Navy and was invited to return to Brown University in September of that year to serve as an instructor in mechanical engineering, which position he held for two years. The summer vacation of 1920 was spent by Mr. Chick as a draftsman in the Philadelphia Inspection Department of the Associated Factory Mutual Fire Insurance Companies, and in June, 1921, he returned to this Inspection Department and spent the following year inspecting industrial plants in the states from New York to Florida.

In June, 1922, Mr. Chick became principal assistant to John R. Freeman, consulting engineer and president of six of the Associated Factory Mutual Fire Insurance Companies. He remain with Mr. Freeman until the latter's death in October, 1932. During this ten-year period he had an opportunity to work on many and varied engineering problems, including among others, the San Diego water supply, the control of the elevation and discharge of the Great Lakes for the Chicago Sanitary District; compilation of the 868-page book "Hydraulic Laboratory Practice;" and the 904-page book "Earthquake Damage and Earthquake Insurance."

Just prior to Mr. Freeman's death in 1932, Mr. Chick undertook to recompute an extensive series of experiments on the flow of water in pipes and pipe fittings that were made by Mr. Freeman at Nashua, N. H., in 1892. Unfortunately, Mr. Freeman died before this work could be completed, but after his death the work was carried on by others under the supervision of Mr. Clarke Freeman and Mr. Chick, and the results were published by the A.S.M.E. in 1941, in a volume of 349 pages entitled "Experiments Upon the Flow of Water in Pipes and Pipe Fittings."

After Mr. Freeman's death, Mr. Chick accepted a position as engineer with the Manufacturers Group of six Fire Insurance Companies, later merged, in July, 1941, in one company, known as the Manufacturers Mutual Fire Insurance Company. In January, 1938, he was made assistant vice-president and engineer of the company, the position which he now holds. His work with the insurance company involves application of engineering principles to the prevention of fire and the protection of industrial plants against interruption of production and loss by fire and other perils. His duties also involve the underwriting and rating of fire-insurance risks valued at over $5,600,000,000.

Mr. Chick joined the Society as a junior in 1921 and became a member in 1934. He has served as a member of the Executive Committee of the Providence Section of the A.S.M.E. and was its chairman 1934–1935. He was a member of the A.S.M.E. Committee on Relations With Colleges from 1937 to 1942 and was chairman of this Committee during the fifth year.

He has served on various committees and in various official capacities for the Providence Engineering Society and was its president during the year of 1937–1938. He was treasurer of the Alumni Association of Brown University from July, 1937, to July, 1943, and also served as vice-president of the Brown University Engineering Association. Mr. Chick was treasurer of the Eastern Section of the Seismographical Society of America for three years, from 1937 to 1939.

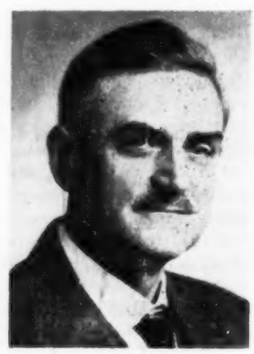
At present Mr. Chick is a member of the Providence Law Revision Committee, appointed by Mayor Roberts in January, 1942, to draft a new building code for the city of Providence, R. I. He served also as a member of the Staff of the Civilian Defense Council in both the city of Providence and State of Rhode Island. He was deputy director of the utilities division of the Providence CD Council and a member of the utility division of the State Council.

During 1944 and 1945 Mr. Chick served as a Manager of the Society and was redesignated Regional Vice-President for 1946. He has been a member of the Executive Committee for three years.

Nominated for Directors at Large

To Serve Four-Year Terms

F. S. BLACKALL, JR.



B. V. E. NORDBERG

Frederick Steele Blackall, Jr.

FREDERICK STEELE BLACKALL, JR., who has been nominated for the office of Director at Large of The American Society of Mechanical Engineers, was born in Roselle, N. J., on November 26, 1896. He was educated at Yale University, being graduated with the class of 1918 with a B.A. degree. He attended the U. S. Naval Academy, Third Reserve Officers School, in 1918, and after a further period of war service, went to the Massachusetts Institute of Technology from which he received his S.B. degree in 1922.

In May, 1922, he entered the employ of The Taft-Peirce Manufacturing Company,

Woonsocket, R. I., manufacturers of machinery and tools; in 1929 he became vice-president and general manager, and since 1933 has been president and treasurer.

Mr. Blackall is a director in the Federal Reserve Bank of Boston, Mass., vice-president and member of the executive committee, and director of the American Wringer Company of Woonsocket, R. I., and its Canadian subsidiary; director, Chamberlain Corporation, Waterloo, Iowa; member Rhode Island Advisory Board, Liberty Mutual Insurance Company; proprietor, Orchard House Farm, Cumberland Hill, R. I.; president, New England Council; president, Woonsocket Hospital; member of corporation, Massachusetts Institute of Technology; director, Woonsocket Community Fund; trustee, Rhode Island United War Fund; vice-president, R. I. Public Expenditure Council; trustee, Woonsocket Taxpayers' Association; member, Boston Ordnance District Advisory Board; chairman, Committee on Fiscal Problems, National Machine Tool Builders Association; member, American Gage Design Committee (chairman, Editorial Committee and member of Standing Committee); member, Gage Industry Advisory Committee, U. S. Army Industrial College.

In 1929 Mr. Blackall became a member of the A.S.M.E. He is also a member of the American Society for Metals; American Society of Tool Engineers; Providence (R. I.) Engineering Society; Army Ordnance Association; The Newcomen Society of England; Sigma Alpha Epsilon; Theta Tau; and F.&A.M.

In 1917–1918 he served in the United States Navy in the United States and overseas, with the rank of Ensign (T) U. S. N.

In World War II he was a member of the U. S. Navy War Manpower Survey Committee, First Naval District; member, Victory Fund Committee (R. I.) member, Precision Tools, and Machine Tool Industry Advisory Committees, War Production Board.

Mr. Blackall has written for magazines and newspapers, including technical and trade journals, on engineering, economic, and historical subjects. He is the author of the original text of the Report of the American Gage Design Committee, published by the U. S. Bureau of Standards, 1930, and editor of all subsequent editions.

Bruno V. E. Nordberg

BRUNO V. E. NORDBERG, who has been nominated for the office of Director at Large of The American Society of Mechanical Engineers, was born March 26, 1884, at Milwaukee, Wis. He received his early education at Milwaukee, attending South Division High School, and graduated from the University of Wisconsin in 1907 with the degree of bachelor of science in mechanical engineering. He stepped into the engineering department of the Nordberg Manufacturing Company immediately upon graduation, and in 1908 assisted in the testing of hoisting installations of the Anaconda Copper Mining Company, at Butte, Mont., which resulted in the development of the pneumatic-hoisting system now employed by that company. From 1910 to 1911 he was erecting engineer for the Nordberg Manufacturing Company and in 1911 to 1913 worked upon the development of the first Uniflow engine built in the United States. His early experience was almost entirely with steam-engine and compressor equipment, which led to many interesting installations in the United States.

From 1914 to 1919 he was interested in the development of oil and Diesel engines. In 1916 he became manager of the oil-engine department of the Nordberg Manufacturing Company and followed the development of solid injection engines which were among the first in the country, as well as the building of the largest Diesel engines so far introduced in the United States. From 1920 to 1922 he acted as sales manager of the Nordberg Manufacturing Company, and was in charge of all products then manufactured by it.

In his present position as executive engineer of the company, which position he assumed in 1923, he continues to be active in engineering projects and new development. He has continued to develop the Diesel engine particularly, as well as its application to direct drive for compressors and pumps and the development of a sensitive governing arrangement adapted for that service. His outstanding contribution was the development of a gas-burning Diesel engine, which resulted in the largest Diesel-engined plant in the world.

He became a member of The American Society of Mechanical Engineers in 1921; was chairman of the Milwaukee Section; chairman of the Regional Delegates Group VI; member of Committees on Power Test Code for Internal Combustion Engines; Power Test Code for Reciprocating Steam Engines; A.S.M.E. Research Committee on Wire Rope.

He is also active as a member of the Special Committee of the U. S. National Committee of the International Electrotechnical Commission; Committee on Engineering, American Bureau of Shipping; Advisory Board, United Inventors and Scientists of America. In addition, he is active as a regent of the Milwaukee School of Engineering; on the Advisory Board of Marquette University and the Advisory Board of the Milwaukee Astronomical Society. He is a charter member of the Engineers' Society of Milwaukee and has been active as president of the Society for two years. He is a member of the Society of Automotive Engineers; Society of Naval Architects and Marine Engineers; V.D.I., North-East Coast Institution of Engineers & Shipbuilders; Society of American Military Engineers; American Interprofessional Institute. He is at the present time holding public positions as vice-chairman of the Sewerage Commission of the City of Milwaukee, and as vice-chairman of the Wisconsin Registration Board of Architects and Professional Engineers. He is also a professional engineer, being licensed with the State of Wisconsin.

His club affiliations include the Milwaukee Yacht Club and the South Shore Yacht Club.

Nominated for Directors at Large

To Serve Two-Year Terms

L. E. MOODY

W. A. CARTER

Lewis Ferry Moody

LEWIS FERRY MOODY, who has been nominated to serve for two years as Director at Large of The American Society of Mechanical Engineers, was born in Philadelphia, Pa., in 1880. He is a graduate of the University of Pennsylvania and received his M.S. degree from that University in 1902. After teaching engineering there for two years, he joined the staff of the I. P. Morris Company. In 1908 he became a member of the

faculty of Rensselaer Polytechnic Institute, first as assistant professor of mechanical engineering, and then as professor of hydraulic engineering, where he remained for eight years. He returned to the I. P. Morris Company in 1912 as part-time consulting engineer and from 1916–1930 he was full-time engineer. From 1908–1916 he also had an independent practice as consulting engineer, and during World War I he was assistant to the vice-president of the Cramp Shipbuilding Company. Mr. Moody joined the faculty of Princeton University in 1930 as professor of hydraulic engineering. At this time he also became part-time consulting engineer for the Baldwin Locomotive Works. He accepted a similar position with the Worthington Pump and Machinery Corporation in 1940.

He is a member of The Franklin Institute, Fellow of the American Association for the Advancement of Science, and member of the Society for Promotion of Engineering Education.

Mr. Moody, who is a Fellow of The American Society of Mechanical Engineers, became a member of the Society in 1910. He is a past-chairman of the Philadelphia Section; past-chairman of the Hydraulics Division; and a member of the Power Test Code Committee. He initiated the formation of the Hydraulic Division.

He has been associated with various research projects, mainly in the field of hydraulics, and has carried out experiments on Pitot tubes, current meters, cavitation, etc., and has developed new types of turbines, pumps, and draft tubes. He has been granted over 90 patents for inventions in his field. He has served on the Advisory Committee of the National Hydraulic Laboratory for the U. S. Bureau of Standards. In 1945 he was awarded the Elliott Cresson Gold Medal by The Franklin Institute.

Besides contributing numerous chapters to engineering books, and papers to various technical publications, he has lectured at Toronto University and Yale and has delivered the Cyrus Fogg Brackett and William Pierson lectures at Princeton. He is a licensed professional engineer for the State of New Jersey.

Wilber A. Carter

WILBER A. CARTER, who has been nominated for the office of Director at Large of The American Society of Mechanical Engineers, was born March 10, 1889, at Aurora, Ill. He grew up in Denver, Colo., and attended the Manual Training High School. In 1913 he was graduated from Cornell University with the degree of M.E. He was a member of Tau Beta Pi and Accacia fraternities. In 1916 he was made a member of Sigma Xi.

Following graduation, Mr. Carter was employed by The Detroit Edison Company and was engaged in the testing of various kinds of power-plant equipment at the Delray Power Plant. When the research department was formed, he transferred to that department and continued there until 1925. His activities in the research department included investigations of various types of mechanical power-plant equipment, gas-generating apparatus and industrial electric-heating processes.

In 1926 Mr. Carter transferred to the production department of the Edison Company and has served it since then as the technical engineer of power plants. In addition to plant-testing responsibilities, he has had important parts in the designing of the Company's power plants.

His membership in the A.S.M.E. began in 1921 and he has served on many committees, including Individual Committee No. 19 (Instruments and Apparatus) of the Power Test Code Committee, the Boiler Furnace Refractories Research Committee, the Power Division Executive Committee, the Standing Committee on Professional Divisions, the Furnace Performance Factors Research Committee, the Standing Committee on Power Test Codes, and the Standing Committee on Publications. Previous to the War he attended a meeting of the International Standards Association in Stockholm, Sweden, representing the American Standards Association in the formation of the ISA "Rules for Measuring the Flow of Fluids by Means of Nozzles and Orifice Plates."

Mr. Carter became a licensed professional engineer in Michigan in 1930 and has engaged in consulting practice in industrial power plants.

T. J. Bannan Elected A.G.M.A. President

THOMAS J. BANNAN, president and general manager, Western Gear Works, was elected president of the American Gear Manufacturers Association at the annual convention of the Association, Hot Springs, Va., June 3 to 5, 1946.

The A.G.M.A. is composed of approximately 125 leading gear manufacturers and many academic members from major educational institutions of the country.

Electrical Engineers Elect Officers

J. ELMER HOUSLEY, district power manager, Aluminum Company of America, Alcoa, Tenn., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1946, it was announced at the annual meeting of the Institute held in Detroit, June 26, 1946. The other officers elected were: Vice-presidents, E. W. Davis, Cambridge, Mass.; O. E. Buckley, New York, N. Y.; T. G. LeClair, Chicago, Ill.; R. F. Danner, Oklahoma City, Okla.; C. F. Terrell, Seattle, Wash., directors, J. F. Fairman, New York, N. Y.; R. T. Henry, Buffalo, N. Y.; E. P. Yerkes, Philadelphia, Pa.; treasurer, W. I. Slichter, Schenectady, N. Y. (re-elected).

King George Honors W. L. Batt

WILLIAM L. BATT, past-president and honorary member, A.S.M.E., formerly vice-chairman, Joint War Production Board, was made an honorary companion of the Order of St. Michael and St. George by King George VI in the Dominion Day honors list, it was announced in Ottawa, Can., June 30, 1946.

Mr. Batt, who was the only American thus honored, served on the Combined Production and Resources Board during the war. The Canadian honors lists, which recognizes civilian war effort, conferred awards on 1190 Canadians.

New Rules Adopted for Boiler Code Symbol

THE Boiler Code symbol stamps, under the procedure formerly in force, were purchased from the A.S.M.E. by manufacturers upon agreement that the symbol stamp would be applied only to constructions built in full accordance with the A.S.M.E. Boiler Code rules and that its use would be indefinite, but subject to surrender at any time upon request of the Society.

This procedure gave the Society only loose control over the use of the symbol stamp. For some time it has been felt that A.S.M.E. responsibility to the public called for a periodic review and reissuance of the agreements authorizing use of the symbol stamp.

Accordingly the Boiler Code Committee recently proposed that future use of the stamp be governed by a certificate of authorization, which would be issued by the Society for a small fee and which would allow use of the stamp for a period of three years, following which the certificate would automatically come up for renewal.

This proposal has the full approval of the state inspection authorities and was approved by the Executive Committee of the A.S.M.E. Council at its May, 1946, meeting.

Covers for July and August Issues of "Mechanical Engineering"

WE are indebted to Prof. A. G. Christie for the photographs which have been reproduced as covers for the July and August issues of MECHANICAL ENGINEERING. The picture used for the July cover showing the reflection of the mountain in the water was selected for exhibition in London by the Canadian Alpine Club and received the highest award. This month's cover was also shown at the Alpine Club and received honorable mention.

Professor Christie is a Past-President and Fellow of the A.S.M.E.

President's Page

An Appreciation of the A.S.M.E. Ladies

In going about among our membership groups one is often most favorably impressed by the part the ladies play in these occasions.

We now have Woman's Auxiliaries in New York, Philadelphia, Chicago, Cleveland, and Los Angeles. Wherever the larger Society Meetings are held around the country ladies' committees are always on the job, inconspicuously but efficiently ministering to our comfort and enjoyment.

By the very nature of things an engineer's life is filled with perplexing problems, large and small, so it is fitting that he should often "throw dull care away" and spend an evening together with the ladies in the lighter vein, particularly since we all subscribe to the feminine appraisal of Sir Walter Scott in "Marmion"—

"Oh woman! in our hours of ease,
Uncertain, coy and hard to please,
When pain and anguish wring the brow,
A ministering angel thou!"

We would encourage the formation of new Woman's Auxiliaries and the strengthening of those already in existence.

Yes, with one voice we A.S.M.E. members say—

"God bless the ladies."

D. Robert Yarnall, *President*, A.S.M.E.

Record Attendance at 18th National Oil and Gas Power Conference Held at Milwaukee, Wis., June 12 to 15, 1946

MORE than 500 members and their guests attended the 18th National Oil and Gas Power Conference held at Hotel Schroeder, Milwaukee, Wis., June 12–15, 1946, making it the largest national meeting ever sponsored by the Oil and Gas Power Division of The American Society of Mechanical Engineers. New records were also set by the exhibit of engines and accessory equipment, in which 36 manufacturers displayed the latest technical advances in the field.

Members attending the Welcome Luncheon, Wednesday noon, June 12, heard greetings extended by the Milwaukee city administration and by representatives of Milwaukee engineering groups, including J. A. Potts, president, Engineers Society of Milwaukee, T. A. Wetzel, chairman, Milwaukee Section, A.S.M.E., and Robert Cramer, Jr., general chairman of the Conference. E. J. Kates, chairman, A.S.M.E. Oil and Gas Power Division, responded to the greetings. In the absence of the luncheon speaker, L. G. Coleman, who was taken ill on the way to the meeting, R. T. Sawyer presented his talk on the history of the Diesel-electric locomotive.

Banquet

A high light of the conference was the banquet, held jointly with the Diesel Engine Manufacturers Association. E. J. Kates, as presiding officer, introduced E. J. Schwanhausser, vice-president, Worthington Pump & Machinery Corporation, and president of D.E.M.A., who acted as toastmaster. A panel of executives of the Diesel-engine industry, in a program arranged by D.E.M.A., discussed the general question of the "Future Outlook for Diesel Engines." Each presented a specific phase of the situation: R. E. Friend, president, of Nordberg Manufacturing Co., director and former president of D.E.M.A., spoke on Diesels in ships and boats; O. O. Lewis, representing R. H. Morse, Jr., vice-president and general sales manager, Fairbanks, Morse and Company, director and treasurer of D.E.M.A., on Diesels in stationary usage; A. W. McKinney, vice-president and general manager of sales, The National Supply Company, director, D.E.M.A., on Diesels in the oil industry; V. C. Genn, sales manager, Detroit Diesel Engine Division, General Motors Corporation, on Diesels on wheels; and L. W. Metzger, vice-president, locomotive and Southwark divisions, Baldwin Locomotive Works, on Diesels on the railroads.

The extensive technical program comprised seven sessions, covering research and new developments, railroad engines, gas-Diesels, marine drives, and gas turbines. At the opening session, Prof. R. B. Rice, University of North Carolina, reviewed recent trends in the field in his "Ten-Year Progress Report on Internal-Combustion Engines." In a companion paper, A. C. Kirkwood, Burns and McDonnell Engineering Company, discussed the possibilities in the use of Diesel engines in steam plants, pointing out the improvement in operating schedules this makes possible.

Two Symposiums

In a symposium on engines for railroad service, J. H. Davids, Fairbanks, Morse and Company, described development of an opposed-piston engine widely used by the Navy during the war and now being applied to locomotives. Hans Bohuslav, Sterling Engine Company, and Ralph Boyer, The Cooper-Bessemer Corporation, dealt with design characteristics of engines of medium size for rail application, and Ralph Miller, Nordberg Manufacturing Company, considered the question of cylinder size for locomotive units.

Considerable interest was attached to another symposium on the development of engines to burn gas, or gas and oil in combination. These engines, relatively new in this country, compress a mixture of gas and air to Diesel pressure levels and employ pilot oil ignition. The principle has been applied to both unsupercharged and supercharged four-cycle engines and to two-cycle units. Speakers at this session were: Ralph Boyer, The Cooper-Bessemer Corporation; Ralph Miller, Nordberg Manufacturing Company; C. E. Cox, Chicago Pneumatic Tool Company; and J. C. Barnaby, Worthington Pump and Machinery Corporation.

Gas Turbines

Rapid strides being made in the field of gas turbines led to a need for two sessions on this subject. In the first, A. D. Hughes, Allis-Chalmers Manufacturing Company, stressed the need for testing high-temperature materials under actual service conditions and described the 3500-horsepower 1500-Fahrenheit experimental gas turbine built for the U. S. Naval Experiment Station and a number of smaller research units designed to explore particular aspects of the high-temperature problem. The second paper, "An Exploratory Excursion Into Patents Concerning Gas Turbines," by E. M. Fernald, professor, Lafayette College, indicated the value of patent literature to the engineer and presented examples of types of patent abstracts that might prove useful. Prof. Fernald's survey, covering the period 1940–45, showed that many developments now coming to light were clearly foreshadowed in the patent literature of some years back.

In the second session, S. A. Tucker,

SPEAKERS AT THE A.S.M.E. OIL AND GAS POWER DIVISION BANQUET HELD DURING THE 18TH NATIONAL OIL AND GAS POWER CONFERENCE AT HOTEL SCHROEDER, MILWAUKEE, WIS.

(*Standing, left to right:* O. O. Lewis, V. C. Genn, L. W. Metzgar, *Seated, left to right* R. E. Friend, E. J. Schwanhausser, A. W. McKinney.)

McGraw-Hill World News, reported on a year's survey of gas-turbine progress abroad, and high-lighted the technical developments made in gas turbines for railroad, marine and stationary applications during the war years when Switzerland was cut off from the outside world. British progress in the aircraft gas-turbine field has been rapid, he said. P. R. Sidler, Brown Boveri Corporation, dealt specifically with developments at his company's works, particularly the test performance of a 10,000-kw gas turbine built for a stand-by power plant at Bucharest, Rumania. The third paper at this session presented a mathematical exposition of regulation theory for closed-cycle gas-turbine plants. Written by F. Salzmann, Escher Wyss Engineering Works, Zurich, Switzerland, the paper was read by T. J. Putz, Westinghouse Electric Corporation.

The session on new developments featured a paper by Ralph Miller, Nordberg Manufacturing Company, in which he presented an analysis of a new system of supercharging with internal cooling by expansion of the air charge. In a companion paper, O. A. Uyehara, P. S. Myers, K. M. Watson, and L. A. Wilson, all of the University of Wisconsin, presented further data on Diesel combustion temperatures. This paper, dealing with the influence of operating variables, represented a supplement to one presented in 1945 on development of research equipment for measuring flame temperatures in a Diesel cylinder.

Discussion of the engineering characteristics of drives for marine propulsion occupied the concluding session of the conference. B. C. Seaman, Elliott Company, presented "The Bowes Drive," and Norman Bremer, Morse Chain Company, presented "Heavy-Duty Chain Drives for Marine Propulsion."

Plant Trips

Members attending the meeting were particularly fortunate in the opportunities offered by an industrial city such as Milwaukee and a number of worth-while inspection trips were scheduled. For those having special interests not covered by the programmed trips, members of the Milwaukee committee made arrangements for private plant visitations. Scheduled trips included the shops of Nordberg Manufacturing Company, manufacturers of large Diesel and gas-Diesel engines, the Falk Company, manufacturers of speed-reduction and mechanical-transmission equipment, and the Ladish Drop Forge Company, manufacturers of Diesel crankshafts, connecting rods, and other parts.

The program for the women attending the conference included a visit to Whitnall Park, famous for its roses and other horticultural displays, a dinner party at the Wisconsin Club, and luncheon and bridge at the Milwaukee Athletic Club.

Committees

Arrangements for the Conference were made by the following committees:

General arrangements: B. V. E. Nordberg, honorary chairman; Robert Cramer, Jr., chairman; T. A. Wetzel, vice-chairman; H. L. Heywood, secretary; M. E. Ruess, treasurer.

Advisory committee: B. V. E. Nordberg, W. C. Lindemann, Ralph Miller, W. B. Tucker, J. H. Gallaway.

Registration: E. T. P. Neubauer, J. V. Resek, A. G. Hoppe.

Meetings: J. E. Schoen, Russell Smith, Donald Doheny, Oertel Lakin, Donald Mertz.

Technical program: R. T. Sawyer, chairman, Hans Bohuslav, Robert Cramer, G. C. Boyer, and P. B. Jackson.

Publicity: C. F. Foell, chairman, John Bunce, and James Karr.

Entertainment: H. L. Heywood, George Haislmaier, R. E. Schultz, James G. Weber.

Inspection Trips: Emil Grieshaber, Forrest Nagler, Donald B. Naulin, A. D. Hughes, Robert Woods, George Wolf.

Exhibits: W. C. Fischer, J. H. Gallaway, K. Morrissey.

Women's program: Mrs. R. C. Newhouse, Mrs. B. V. E. Nordberg, and Mrs. E. T. P. Neubauer.

6000 Attend Annual Safety Conference in New York, N. Y.

At THE Sixteenth Annual Safety Conference of Greater New York Safety Council held at Hotel Pennsylvania, New York, N. Y., April 9 to 12, 1946, engineers had a splendid opportunity to see, hear, and mingle with those zealots of industry who are convinced that accidents are an unnecessary evil, that they can be avoided, and that doing the right thing the correct way at the right time prevents accidents.

A.S.M.E. Members Participate

These annual safety conventions have demonstrated their value to industry in providing engineers and executives with the means of meeting at sessions to compare the plans, devices, and methods that they have employed with those adopted for operation in other plants. In that connection it was noted that many members of A.S.M.E. were present at various sessions of the convention either as part of the audience or as members of technical discussion panels.

Humane considerations are ever-present in the desire of industrial executives to prevent accidents to workers. However, the cost factor of such accidents is of paramount importance as an influence on production expense. As engineers, we are much concerned with production cost. Since accidents, be they mechanical in their origin or otherwise, do affect such costs, it is essential that engineers familiarize themselves with the underlying causes of the mistakes that lead to personal injuries, spoilage of work, damage to machines, and interruption of production.

Elevator Safety Session

At the forty-five sessions of the safety convention the majority of the chairmen and speakers were executives representing the principal industries in the United States east of the Mississippi River. At the session on elevators, where J. A. Dickinson, member A.S.M.E., was vice-chairman, keen interest was shown in subjects of construction and maintenance of operating mechanism of elevators, escalators, hoistway door interlocks, and wire inspection and replacement.

A number of "clinics" were held for presentation and discussion of the engineer's part in the design of mechanical equipment for safe operation, the value of gaining workers' confidence in the knowledge that hazards have been eliminated or controlled and the net results obtained in the production schedule and cost as a result of safety in design and operation.

In the session on shipyards a number of managers and assistant managers of this country's largest shipyards described the shipbuilding and repair methods carried on by them during war years, how numerous difficult problems were encountered and overcome, the contribution of their engineers in solving those problems and how accidents were successfully controlled by anticipating the difficulties frequently before they occurred.

Safety Color Code

What is the effect on industrial safety through the use of the American Standard Safety Color Code? There was a consensus of opinion that the Standard Color Code is an instrument of much value because it indicates safe and unsafe locations, equipment and devices; guides workers in safe practices; and aids plant management in better maintenance.

The Automotive Section held an interesting session on the use, operation, and maintenance of autotrucks, cars, and industrial motors. The safe-load capacity of wire rope used in derrick, crane, and other hoisting operations was discussed at considerable length; also the effective maintenance and determination of fatigue of hoist ropes.

Safety management, as an aid in developing co-operative attitudes on the part of subordinates and workmen for smooth production, was given attention at a session. Speakers described persuasive methods which have resulted in voluntary acceptance of mandatory provisions by plant workers. An excursion into the field of human factors of accident control should be attractive to those professional engineers whose responsibilities include plant or departmental management. There is still much territory in the field of industrial management for research on control of the human factor to devise methods for increase in both quality and quantity of production.

President Truman Honors R. D. Mindlin

Dr. RAYMOND D. MINDLIN, member A.S.M.E., associate professor of civil engineering, Columbia University, New York, N. Y., has been awarded the Medal for Merit by order of President Truman for his wartime work in the development of the radio proximity fuse, an offensive weapon regarded by military experts second only to the atomic bomb in the winning of the war.

A.S.M.E. 1946 Fall Meeting in Boston, Mass., Sept. 30 to Oct. 3, 1946

THE 1946 Fall Meeting of The American Society of Mechanical Engineers will be held at Hotel Statler, Boston, Mass., Sept. 30 to Oct. 3, 1946.

A four-day program consisting of technical sessions, luncheons, dinners, and plant trips has been planned by an enthusiastic committee of the A.S.M.E. Boston Section.

Technical Sessions

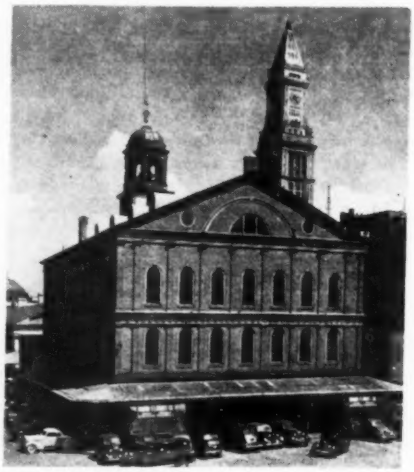
The tentative program calls for 21 technical sessions on the following subjects: Aviation, Education and Training, Fuels, Heat Transfer, Hydraulics, Machine Design, Management, Metals Engineering, Power, Production Engineering, Textiles, and Wood Industries. Most of the technical sessions have been planned for the mornings and evenings so that the afternoons will be left free for plant trips.

Plant Trips

As an old industrial center, Boston and its environs is the home of a variety of industries. Free from the call of technical sessions, members will be able to take full advantage of invitations to visit such plants as the General Electric Company plant at Lynn, the Mystic Station of the Boston Edison Company, the Fore River shipyards of the Bethlehem Steel Company, the Quincy Market and Cold Storage Company at the Fish pier, in addition to museums, educational institutions, and the many historical shrines that abound in Boston.

Committee

The general committee for the 1946 Fall Meeting of the A.S.M.E. Boston Section consists of the following: Chairman, H. M. King; secretary, C. B. Seelig; technical events, chairman, Kerr Atkinson, vice-chairman, C. R.



FANEUIL HALL, BOSTON, MASS.

Soderberg; printing and signs, chairman, E. L. Root, vice-chairman, R. L. Williams; hotels, chairman, Fred Farrell; entertainment, chairman, W. F. Ryan, vice-chairman, H. S. Houghton; plant trips, chairman, G. K. Saurwein, vice-chairman, F. M. Carhart; information and registration, chairman, S. S. Perry, vice-chairman, E. K. Bancroft; publicity, chairman, G. A. Orrok, Jr., vice-chairman, H. L. Von Rehberg; reception, chairman, I. E. Moultrop; ladies' program, chairman, Mrs. C. Harold Berry; and finance, chairman, R. D. Stauffer, vice-chairman, H. W. Dawes.

A detailed program of the A.S.M.E. 1946 Fall Meeting will be published in the September issue of MECHANICAL ENGINEERING.

A. W. Luce Joins Faculty of Pratt Institute

ALEXANDER W. LUCE, member A.S.M.E., formerly with The Fellows Gear Shaper Company, Springfield, Vt., will join the faculty of Pratt Institute, Brooklyn, N. Y., on Sept. 1, 1946, as chairman of the curriculum and head of the department of mechanical engineering.

He will assume the duties of Alfred W. Doll, member A.S.M.E., who has been promoted to supervisor of basic instruction and head of the department of physics.

1946 Diamond Jubilee Year of A.I.M.E.

THE 75th Anniversary of the American Institute of Mining and Metallurgical Engineers was commemorated by a diamond jubilee meeting of the Pennsylvania-Anthracite Division of the Institute at Hotel Sterling, Wilkes-Barre, Pa., June 7, 1946.

Since its organization by a group of 46 mining engineers at Wilkes-Barre in 1871, the Institute has grown into an organization composed of six professional divisions and 35 local sections with membership of more than 15,000 engineers, 20 per cent of whom live outside the continental limits of the United States.

In his diamond-jubilee address, Louis S. Cates, president, A.I.M.E., characterized the last 75 years as an era of unequaled progress in the history of the world. He stated, "A large measure of this progress is the direct result of the achievements of mining engineers, petroleum engineers, and metallurgists in successfully seeking, extracting, and bringing into expanded use our mineral assets. As members of this Institute we can, and do, take justifiable pride in this fact."

A.S.M.E. Calendar

of Coming Meetings

September 16–18, 1946
Industrial Instruments and Regulators Division Meeting with Instruments Society of America
Pittsburgh, Pa.

September 30–Oct. 3, 1946
A.S.M.E. Fall Meeting
Boston, Mass.

October 7–9, 1946
Meeting of Petroleum Committee of Process Industries Division
Tulsa, Okla.

October 24–26, 1946
Joint A.I.M.E. Coal and A.S.M.E. Fuels Division Meeting
Philadelphia, Pa.

December 2–6, 1946
A.S.M.E. Annual Meeting
New York, N. Y.

British Engineers Appeal for Aid in Preservation of Historic Engines

THE Cornish Engines Preservation Society of Britain is appealing to American engineers and engineering organizations for aid in the preservation of several early nineteenth-century steam pumping engines which have been in service for close to 100 years in the tin- and copper-mining district of Cornwall, England.

These historic engines, some of them placed in service before the time of the American Civil War, all represent successive contributions of such early engineers as Newcomen, Smeaton, Watt, Hornblower, Trevithick, and others. When Richard Trevithick improved on the efficiency of the Boulton and Watt engines in the first quarter of the nineteenth century, a large number of these engines were installed by the mine owners of Cornwall for purposes of mine drainage.

One engine of this type, the 100-inch Harvey engine installed at the Kew Station of the Metropolitan Water Board of London in 1869, pumped eight million gallons per day continuously until it was shut down in 1942.

The Cornish Engines Preservation Society aims to acquire several of these giant engines along with enginehouses and the sites as monuments to the engineering genius of the Cornish mining engineers. The proposal to preserve the engines on their sites and eventually to establish a mining and engineering museum in the vicinity, has won the support of many of the engineering societies and institutions of England.

Since American engineers share the heritage of the era of engineering development represented by the Cornish engines, the Cornish Engines Preservation Society feels that American engineering institutions may wish to contribute to the work of the society. Gifts and requests for membership in the society will be welcomed. These should be directed to the Honorable Secretary, Cornish Engines Preservation Society, Observatory, Falmouth, Cornwall, England.

Tentative Program of the I.I. & R. Division Meeting in Pittsburgh, Pa., Sept. 16 to 18, 1946

The first national meeting of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers will be held at the William Penn Hotel, Pittsburgh, Pa., Sept. 16 to 18, 1946, in conjunction with the exhibit and conference "Instrumentation for Tomorrow" sponsored by the Instrument Society of America.

Three technical sessions have been planned during which twelve papers will be presented. The papers will cover recent developments and current problems in the field of control instrumentation.

On Wednesday, Sept. 18, the Industrial Instruments and Regulators Division of the A.S.M.E. will hold a joint meeting with the Instrument Society of America on automatic-control terminology.

The I.I. & R.D. banquet will be held Monday, Sept. 16, and general luncheons will be held on Monday and Tuesday of the meeting.

Members planning to attend the meeting are asked to make hotel reservations early because of the scarcity of hotel accommodations. If the hotels fail to honor requests for accommodations, members are asked to write to John McQuilken, Instrument Society of America, 1117 Wolfendale Street, Pittsburgh 12, Pa., who will endeavor to obtain reservations elsewhere.

MONDAY, SEPT. 16

9:00 a.m.

Registration

12:00 noon

General Luncheon

2:00 p.m.

Symposium on Controllability of Combustion Processes

Chairman: E. G. Bailey, Babcock and Wilcox Company

Recorder: Thomas E. Purcell, Duquesne Light Company

Uncontrollability Factors in Boiler Operation by Joseph A. Pelletere, Gulf Oil Corporation, Pittsburgh, Pa.

Items of Controllability in the Open-Hearth Combustion Process, by Andrew J. Fisher, fuel engineer, Bethlehem Steel Company, Sparrows Point, Md.

The Blast Furnace—Chief Uncontrollable in All Industry, by Walter Flanagan, consulting engineer, Carnegie-Illinois Steel Company, Pittsburgh, Pa.

Combustion Control—Influence of Fuel-Burning Equipment on Design, by P. S. Dickey, chief engineer, Bailey Meter Company, Cleveland, Ohio

7:00 p.m.

Banquet

TUESDAY, SEPT. 17

9:00 a.m.

Gas Analysis Instrumentation

Chairman: W. Trinks, consulting engineer, Pittsburgh, Pa.

Recorder: L. E. F. Wahrenburg, vice-president, Peter Loftus Company, Pittsburgh, Pa.

Principles of Quantitative Gas Analysis and Testing, by A. W. Gauger, professor of fuel technology, The Pennsylvania State College.

Precision Analysis of Engine Exhaust Gas, by C. W. Butler, M. J. Boegel, and R. P. Jones, all of Gulf Research and Development Company, Hamarville, Pa.

N.A.C.A. Gas-Analysis Instrumentation for Aeronautical-Engine Research, by William H. Haynie and H. C. Gerrish, both of the National Advisory Committee for Aeronautics, Aircraft Engine Research Laboratory, Cleveland, Ohio

Four New Methods of Industrial Gas Analysis, by H. D. Middel, industrial-engineering division, General Electric Company, Schenectady, N. Y.

12:00 noon

General Luncheon

2:00 p.m.

Flow Measurement and Control

Chairman: Arthur J. Kerr, vice-president, Rockwell Manufacturing Company, Pittsburgh, Pa.

Recorder: L. E. Hankison, West Penn Power Company, Pittsburgh, Pa.

Cascaded and Multiple Automatic-Control Systems, by A. A. Markson and M. J. Boho, both of Hagan Corporation, Pittsburgh, Pa.

The Positive Meter as a Flow-Rate Control Device, by E. W. Jacobson, chief design engineer, Gulf Research and Development Company, Hamarville, Pa.

An Extension of Rotameter Theory and Its Application, by Victor P. Head, fluids research engineer, Fischer and Porter Company, Philadelphia, Pa., and Kermit Fischer, president, Fischer and Porter Company, Philadelphia, Pa.

Nozzle Flow Characteristics in Pneumatic Force-Balance Circuits and Application to Automatic Flow-Rate Control, by D. B. Kirk, chief engineer, Moore Products Company, Philadelphia, Pa.

WEDNESDAY, SEPT. 18

9:00 a.m.

Joint Session With the Instrument Society of America Automatic-Control Terminology

Chairman: J. C. Peters, control engineer, Leeds and Northrup Company, Philadelphia, Pa.

Recorder: Lyman J. Van Der Pyl, chief chemist, Rockwell Manufacturing Company, Pittsburgh, Pa.

Graphic Representation and Analysis of Automatic-Control Terminology, by Joseph G. Horn, Brown Instrument Company, Philadelphia, Pa.

Functional Analysis of Measurement Apparatus, by H. C. Dickinson, General Electric Company, Schenectady, N. Y.

A.S.M.E. Petroleum Committee to Hold National Meeting in Tulsa, Okla.

On October 7, 8, and 9, 1946, the Petroleum Committee of the Process Industries Division of The American Society of Mechanical Engineers will hold a national conference on Petroleum Mechanical Engineering at the Mayo Hotel, Tulsa, Okla. The first conference of this name was held at Tulsa, Okla., in 1930. The 1946 conference represents the most important move in the more than two years of effort that have been put into reviving the interests of the Society in the mechanical-engineering problems of the petroleum industry.

Planned for three days and strategically located in the heart of the Mid-Continent petroleum area, the conference is expected to attract at least 400 men interested in the production of crude oil; pipe line transportation of crude and refined products; refining; construction materials used throughout the industry; petroleum-equipment manufacture; and the application of the industry's products. Grouped under topical classifications approximating these headings will be 17 or more technical sessions at which some 40 papers will be presented. These papers will be available initially as preprints, and later, they may be assembled in booklet form for distribution to all who register at the meeting.

Social affairs will include a luncheon at the Tulsa Engineers' Club at noon the first day, a smoker and general get-together on the first evening, and a banquet to be addressed by speakers of national prominence on the second evening. An authors' breakfast on the second day will be followed at noon by luncheon meetings of a number of groups having like technical interests, at which new officers will be chosen for each group and organizational and other business problems will be considered. Present plans anticipate a local section luncheon at noon on the third day.

A final program with final details on arrangements will be mailed during August to those who have already signified an interest in the work of the Petroleum Committee, and to those who request this information. Inquiries should be addressed to E. W. Jacobson, secretary, A.S.M.E. Petroleum Committee, Gulf Research and Development Company, P. O. Drawer 2038, Pittsburgh 30, Pa.

Committees

Plans for the technical sessions and arrangements for all papers and discussion have been made by the Petroleum Committee under the chairmanship of William Raisch, chief engineer, Borough of Queens, New York, N.Y., with the aid of E. W. Jacobson, Gulf Research & Development Company, Pittsburgh, Pa., secretary of the Petroleum Committee, and the following subcommittees: Applications, headed by C. L. Pope, Eastman Kodak Company, Rochester, N. Y.; Construction Materials, headed by B. B. Morton, International Nickel Company, New York, N. Y.; Equipment Manufacturers, headed by J. M. Sexton, M. W. Kellogg Company, New York, N. Y.; Production, headed by G. L. Kothny, Sperry-Sun Well Surveying Company, Philadelphia, Pa.; Refining, headed by Irving Taylor, The Lummus Company, New York, N. Y.; Transportation, headed by E. W. Jacobson, Gulf Research and Development Company, Pittsburgh, Pa.; and Papers and Publications, headed by T. R. Olive, McGraw-Hill Publishing Company, New York, N. Y.

Local arrangements are being made, with the co-operation of the Petroleum Committee, by the A.S.M.E., Mid-Continent Section at Tulsa, Okla. The local section has appointed a special committee for this purpose, consisting of the following: Orval Lewis, general chairman; D. E. Foster, vice-chairman; and Carl Stevens, secretary; R. G. Ayers, entertainment; D. E. Fields, finance; R. B. Tuttle, publicity; Clarence Glasgow, registration; D. A. Cant, programs and hotels; and L. T. Gibbs, plant trips.

Hotel Accommodations

Tulsa is a good convention city and the dates for the conference have been chosen at a time when no other convention will be in progress. It will be desirable, nevertheless, for those who plan to attend to make reservations as soon as possible at the Mayo Hotel or Tulsa Hotel. Reservation requests should be sent direct to the hotel, naming the dates of October 7, 8, and 9, and the Second Conference on Petroleum Mechanical Engineering. Those at present on the Petroleum Committee's mailing list, and those who request the secretary to be put on the list, will receive forms to facilitate room applications and the registration for the luncheons and social affairs. Where possible, however, reservations can be made more certainly without awaiting the receipt of this material.

Program

A detailed program of the meeting listing authors and papers will be published in the September issue of MECHANICAL ENGINEERING.

NEW LECTERN USED BY MILWAUKEE SECTION

[This streamlined welded-sheet-aluminum lectern bearing an engraved bronze A.S.M.E. emblem with blue field was constructed under the supervision of Sebastian Judd (behind lectern) past-secretary of Milwaukee Section. The indirectly lighted upper portion is removable for use on a banquet table and the lower stand is fitted with a locked door and shelves for water pitcher and tumblers. Others on the lectern committee were Sam Gates, Eric Laabs, Ted Eserkaln, Erny Huber, and Bob Cramer.]

Sections

Chicago Section Enjoys Spring Outing

On May 18 a meeting was held at the Michigan Shores Club, Wilmette, Ill. An afternoon of swimming and bowling was enjoyed by the men, and an Auxiliary bridge party by the ladies. A cocktail hour, dinner, water ballet, short business meeting, and social hour and dancing followed. There were 190 at the event. The business meeting consisted of the presentation of student awards to J. C. Whitney, of the Illinois Institute of Technology, and J. M. Frank, of Northwestern University. The nominating committee announced that the entire slate, headed by Prof. B. H. Jennings as chairman, was elected.

Mid-Continent Section Hears Talk on "Design of Heaters for Petroleum Industry"

The regular monthly meeting was held on May 23 in the Chamber of Commerce dining room, Tulsa Building, Tulsa, Okla. A paper on "The Design of Heaters for the Petroleum Industry" was presented by J. H. Rickerman of the M. W. Kellogg Company, New York, N. Y. Mr. Rickerman discussed the different types of construction, heat absorption, efficiencies, calculations of tube sizes, radiant and convection section design, and gave some good advice on other details of design. A lively discussion followed. The paper was well received by the engineers of the Section since this is principally a petroleum-industry section. There were 85 members and visitors present.

Southern California Section Closes Season with Inspection Trip

A dinner meeting was held on June 27 at the Rodger Young Auditorium, Los Angeles, Calif. P. T. Thornton, of the sales department, Aluminum Company of America, spoke on "Recent Developments in Aluminum." The talk was illustrated with a motion picture. Roy E. Payne, chief metallurgist of the Vernon plant was also present. On June 28 the members visited the Alcoa Vernon plant, where foundry, forge, tube mill, extrusion, rivet, and ingot plants were shown.

Virginia Section

On May 6 at the Hotel Roanoke, Roanoke, Va., Dr. Oscar J. Horger, member A.S.M.E., chief engineer, railway division, The Timken Roller Bearing Company, Canton, Ohio, gave an address on "Design and Fatigue Strength of Machine Parts." The talk was illustrated with slides which showed test data on the effects of fillets and shot-peening of shafts. The 50-Year Membership badge was presented to J. A. Pilcher, retired mechanical engineer, Norfolk and Western Railway Company. The presentation was made by E. E. Williams, vice-president A.S.M.E., Region IV. Eighty-six enjoyed the dinner and program.

A joint meeting program was held at the Hotel Nansemond, Norfolk, Va., on May 24 and 25, with the following participating: Virginia Section A.S.M.E., A.S.C.E., A.I.E.E., A.I.A., A.C.S., Society of American Military Engineers, Engineers Club of the Virginia Peninsula, and Engineers Club of Hampton Roads. Technical sessions were held each day. On May 24 Edward E. Williams, vice-president A.S.M.E., Region IV, Duke Power Company, gave an address on "Engineering and Citizenship."

Western Washington Section Annual Spring Meeting With University of Washington

On May 29 at the Faculty Club, University of Washington, Seattle, Wash., the annual spring joint meeting of the Section and the University of Washington student branch was held. The results of the student-paper contest were as follows: First, Robert G.

Hunter, "Interchangeability Control in Aircraft Manufacture;" second, Harry L. Pratt, "Tests of Postwar Gasoline;" third, Wm. E. Meneley, "The Hay Drier, a Special Problem in Heating and Ventilating;" fourth, Richard H. Brown, "Cold Treatment of Steel." Prizes of handbooks and the autobiography of some noted engineer were given to the first three winners.

Eighteen members of the Section and 24 students attended.

On June 12 at the Gowman Hotel, Seattle, Wash., L. C. Bibber, welding engineer, Carnegie Illinois Steel Corporation, spoke on "The Elements of Welded Design." During his lecture Mr. Bibber showed many slides of construction and design of welded joints, structures, and many other applications. The audience totaled 120, as members of the A.S.M. and A.W.S. were guests of the Section.

The Electrical Engineering Exposition to Be Held in New York, N. Y.

THE Electrical Engineering Exposition, originally planned for Philadelphia, Pa., in 1941, but postponed because of the war, will take place in New York, N. Y., at the 71st Regiment Armory, Jan. 27 to 31, 1947.

The Exposition will be held concurrently with the winter convention of the American Institute of Electrical Engineers.

A.I.M.E. to Sponsor World Conference in March, 1947

A WORLD Conference on Mineral Resources will mark the 75th anniversary celebration of the American Institute of Mining and Metallurgical Engineers. The conference will be held in conjunction with the annual meeting of the A.I.M.E. at the Waldorf Astoria Hotel, New York, N. Y., during the week of March 17, 1947.

Louis S. Cates, president, A.I.M.E., will deliver the welcoming address. Distinguished speakers have accepted invitations to speak on such subjects as "Mineral Resources of the United States," "Latin-American Minerals in the Future World Economy," and "Chemical Raw Materials of the Future."

Free Catalogue of A.S.A. Standards Available

A REVISED Catalog of American Standards containing a list of 845 standards approved and published by the American Standards Association, including 154 American War Standards used during the war by the War Production Board, has been made available free of charge by the A.S.A.

Requests for copies should be addressed to the American Standards Association, 70 East 45th Street, New York 17, N. Y.

Student Branches

Group V Student Meeting Held at Notre Dame

The Fourteenth Annual Conference of the Midwest Group V student branches was held at the University of Notre Dame, Notre Dame, Ind., on April 29 and 30, 1946. The student branches from the following Midwest schools were represented: University of Detroit, Rose Polytechnic Institute, University of Illinois, University of Wisconsin, Michigan State College, Illinois Institute of Technology, Purdue University, University of Minnesota, University of Notre Dame, Michigan College of Mining and Technology, Marquette University, and Northwestern University.

As in former years, the principal feature of the conference was the competition for prizes for the best talks on various aspects of engineering. A student representative from each of the colleges delivered his talk on a topic of interest to the group. The first prize of $50 was won by Arthur Schmitt, member student branch A.S.M.E., University of Wisconsin, for his paper "99 44/100 Per Cent Dry—It Floats," which dealt with the solution of the problem of the flow of carbon black. Second prize of $25 was won by Edward W. Jerger, member student branch A.S.M.E., Marquette University, for his talk on "Aircraft-Engine Fire Protection." Prizes were also awarded to John B. DeGarmo, Northwestern University, Kenneth J. Cleereman, Michigan State College, and Martin Kilsdonk, University of Notre Dame.

At the annual luncheon T. S. McEwan, vice-president, Region VI, A.S.M.E., commended the students for the fine representation, and congratulated the speakers for their work in preparing and presenting these technical papers. At the banquet John C. Straub, research engineer, American Foundry Equipment Company, Mishawaka, Ind., gave an interesting talk on "Shot Peening," in which he explained its uses in strengthening materials. At the close of the conference the student members were taken on a conducted tour of the American Foundry Equipment Company's plant.

Alabama Polytechnic Institute Branch

The first meeting of the summer quarter was held on June 24 in the Ramsey Engineering Building, and officers elected for this quarter as follows: William Smith, chairman; James E. Williams, vice-chairman; Magalyn Barranco, secretary; Elizabeth Clinkscales, corresponding secretary; William Mullins, treasurer; Herbert Holdsambeck, representative to Engineering Council.

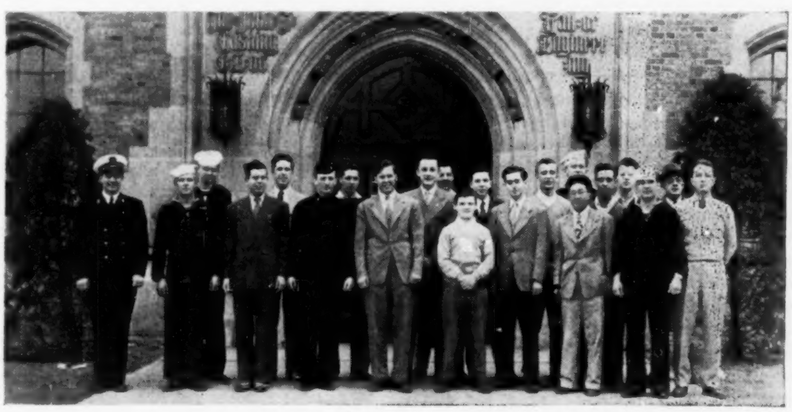
Cornell University Branch

On June 7 at the Club Claret, Ithaca, N. Y., a banquet meeting was held jointly with the Ithaca Section. Following dinner, a talk was given by G. V. Alf Malmros, manager of the acoustics laboratory, International Business Machines Corporation, Binghamton, N. Y., entitled "Noise—Its Cause and Cure." Mr. Malmros showed some interesting and varied equipment to illustrate his talk. Sixty were in the audience.

Georgia School of Technology Branch

The meeting on May 14 was called to order by President Schneider, who introduced the speaker, F. W. Ajax, associate dean of students, Georgia School of Technology. Mr. Ajax gave an interesting talk on "Employment Opportunities for Mechanical Engineers." He said that mechanical engineering was the most flexible and basic degree, basing this statement on the demand by industry for mechanical engineers which came to his office. He mentioned types of jobs being offered to graduating mechanical engineers and the procedure taken to secure such employment through his office.

On May 28 election of officers for the fall quarter was held, with the election of Don Deiters, president; Johnny Bethune, vice-president; Owen Sheetz, secretary-treasurer;



STUDENT BRANCH OF THE UNIVERSITY OF NOTRE DAME

and Prof. A. D. Holland, member A.S.M.E., honorary chairman.

The speaker at the June 4 meeting was Carl W. Evans, editor of *Electrical South*, and president of the Georgia Society of N.S.P.E. and A.I.E.E. His talk was on the very timely and interesting subject "Unification of the Engineering Profession." With the aid of slides Mr. Evans illustrated four methods which had been proposed for this unification.

Marquette University Branch

On May 30 a meeting was held in the Student Room. Announcement was made that Edward W. Jerger won second place in the technical session at the regional meeting of the A.S.M.E. at Notre Dame University. Election of officers was held, with the following elected for the summer quarter: Edward W. Jerger, president; Robert Dams, vice-president; William Pautke, secretary; Mike Knesevich, treasurer. By an overwhelming vote Prof. John E. Shoen was chosen honorary chairman.

University of Michigan Branch

On May 8 a meeting was held in Michigan Union. Prof. E. T. Vincent, speaker of the evening, gave a talk on "Transportation by Atomic Power." He dealt with the applications of turbines and jet propulsion to automotive machines, describing the intermediate steps dealing with reciprocating, turbine, turbo-jet, and ram-jet engines.

At the meeting on May 29 a film entitled "Maintenance and Operation of Steam Locomotives," loaned by the New York Central Railroad Company, was shown. Election of officers for the coming semester was held, with the following results: David VanTuyl, president; Frank Anon, vice-president; Donald Steibel, secretary-treasurer; John Cox, engineering council representative. The new president then took over the meeting.

University of Nevada Branch

The final meeting of the current semester was held on May 28 in room 201, New Engineering Building. Two films were shown through the courtesy of the California Institute of Technology's jet-propulsion laboratory. The films, which were in technicolor, were "Jet-Propulsion Development," and "V-2 Launching,"—the latter a captured German film. An open discussion on jet propulsion followed.

Oregon State College Branch

On May 23 in room 212, Apperson Hall, the meeting of the Oregon State College student branch was called to order by chairman Ed Boyer. Nominations and election of new officers for the coming year gave the following results: Don Benz, chairman; Alice Widmer, vice-chairman; Matt Braich, secretary; Howard Long, treasurer; Henry Meyer, sergeant at arms. Professor Arents gave a résumé of the meeting of the Northwest Engineers Council which he attended in Seattle this spring. He said that the Northwest Student Engineers Council would be held on Oregon State campus next year. After the business meeting a film on aluminum was shown, illustrating the different processes employed in manufacturing various products.

Rice Institute Branch

At the last meeting of the school year, on June 6 in Chemistry Lecture Hall, two entertaining films were shown, the first "Let's Go Fishing," and the second, "Lest We Forget." The latter described the evolution of the automobile.

University of Rochester Branch

On June 4 a meeting was held in Rush Rhees Library. Election of officers for the September, 1946—January, 1947, term was held, with the following elected: John Mount, chairman; James Kinney, vice-chairman; Edward T. Kern, secretary; Al Harrot, treasurer. Prof. Lawrence Hill was recommended for honorary chairman. A talk was given by Dr. R. J. Raudebaugh entitled "Recent Developments and Trends in Metallic Materials."

University of Southern California Branch

On June 12 in the Engineering Building officers elected for the coming semester were: Henry A. Hoste, chairman; Robert Blumenthal, vice-chairman; Robert Sand, secretary; Robert Roos, treasurer. The new officers were approved by E. Kent Springer, member A.S.M.E., honorary chairman.

Tufts College Branch

On May 30 the speaker was Millard Dowell, research engineer for the General Electric Aircraft Gas Turbine Department, Lynn, Mass. Mr. Dowell spoke on "High-Speed Photography as Applied to Airflow," and illustrated his talk with original slides of motion pictures taken in the laboratory. A lively discussion period followed the lecture, after which refreshments were served. Holcombe J. Brown attended the meeting as guest. Mr. Brown is the representative on the Committee on Relations With Colleges from Boston, Mass., and his presence was welcomed by all.

University of Wisconsin Branch

A dinner meeting was held at Tripp Commons of the Memorial Union on April 16 at which the student members of the local S.A.E. branch were guests of the Milwaukee Section. The S.A.E. members present were: Howard Wiles, Harry Roorda, and Royce Childs of the Waukesha Motor Company; Ed Bryant and Dean Thomas of the Nelson Muffler Company; George Haiselmaier of the Young Radiator Company; Professor Russell Fowler of the University Extension Department; Prof. L. A. Wilson, member A.S.M.E., of the University of Wisconsisn; and T. L. Swansen and Forest Nagler of Allis Chalmers. The latter, who is chief engineer of Allis Chalmers Company, gave a talk on "Choosing the Material for the Job," which was illustrated with slides and slow-motion pictures.

On May 14 a meeting was held in Top Flight, Memorial Union, when nominating committees were named for the next semester's officers, consisting of George Holloway and Ed Hillery for A.S.M.E., and Russell Baetke and Oiva Maki for S.A.E. John Jenkins and Mr. Shurts of the Twin Disc Clutch Company, were guests. Mr. Shurts, who has recently been to Europe to inspect Axis equipment, gave an illustrated talk on hydraulic couplings and torque converters. The color film showed commercial applications and brought forth more detailed questions which Mr. Shurts answered by referring to his breakdown samples.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

GRADUATE MECHANICAL ENGINEER, 26, married. Five years' experience in design, test, supervision of manufacture, installation, repair power-plant equipment, and naval ship repair supervision. Preference, East. Me-67.

AERONAUTICAL ENGINEER, graduate, 30, married. Six years' design, research and testing experience in field of vibration control, desires similar position with progressive manufacturer in East. Ideas applicable to industrial field. Me-68.

MECHANICAL ENGINEER, graduate, age 36,

[1] All men listed hold some form of A.S.M.E. membership.

married. Fifteen years' diversified industrial experience in power, petroleum, machine, air conditioning, and paper. Thoroughly familiar product and machine design, processes, plant methods, and marketing practice, national basis. Desires permanent position requiring administrative ability. Me-69.

Mechanical Engineer, 28, B.S. 1940. Three and one half years' aircraft production and modification engineering. Two and one half years' varied experience. Partial to industrial sales engineering or production engineering. Will consider other fields. Me-70.

Director of Research, development of consumer products, housing, or home equipment. Mechanical-electrical-structural engineering experience. Familiar with modern manufacturing processes and administration. Five years' consulting practice. Age 33. Me-71.

Mechanical-Executive Engineer, graduate U.S.N.A., B.S., 22 years' diversified naval experience, inspector machinery, ordnance and navigation material; submarines; repair officer; chief engineer Diesel and steam; instructor engineer; executive officer; commanding officer. Available September, any location. Me-72.

Graduate Mechanical Engineer, 22, married, recently discharged Naval officer, worked as draftsman previous to entering engineering school. Me-73.

Graduate Mechanical Engineer, 26, married. Outstanding scholastic record. Two and one half years steam-generator field engineering and research. One and one half years' Navy electronics experience. Capable artist and writer. Desires position in technical-publicity field. Me-74.

Recent Mechanical Engineering Graduate from Stevens Institute of Technology, in upper 10 per cent of class. Since then have been engineering officer aboard Navy transport before release on August 1, 1946. Interested in design, production, or steam power. Me-75.

Graduate Mechanical Engineer, 25, single, naval lieutenant, two years' experience in ship repair work. Desires engineering connection in, or leading to, development work. Will Locate where opportunity is best. Me-76.

Executive Engineer, 20 years' experience. Designing and supervising construction and operation all types rubber-products manufacturing plants, also power, heating- and pumping-station plants. Combustion, consulting, etc. Available immediately. Me-77.

Registered Professional Engineer, mechanical graduate, 33 years' experience. Plant engineering and construction, equipment layout, tool engineering. Small motors, paper, plastics, chemicals. Desires position, plant engineer, superintendent. New England. Me-78.

POSITIONS AVAILABLE

Mechanical or Chemical Engineer with several years' experience in paper and pulp industry. Will be required to supervise design of equipment for several plants manufacturing felt. Traveling. $7200 year. Headquarters, New York, N. Y. W-7289.

Office Engineer with 5 or more years' experience with boilers or unfired pressure vessels, either design or construction. Should have some knowledge of stress analysis and able to conduct meetings. Salary, $4800–$5400 a year. New York, N. Y., W-7308.

Mechanical Engineer, graduate, 28–35, with at least 5 years' recent active experience in designing equipment, structures and other facilities at plants to determine suitability and efficiency, for this type of work. Will also recommend to plants, equipment, supplies, and engineering methods for their consideration. Experience on equipment such as packaging, wire drawing, or cutting, can manufacturing, or similar work helpful. Will be engineering assistant to vice-president of operations. $4200–$5100 year. Northern New Jersey. W-7310.

Engineers. (*a*) Heating and ventilating engineer to 50, with mechanical-engineering training and approximately 10 years' experience in heating, refrigeration, air-conditioning, ventilating and heat-transfer problems, with background of estimating, designing, and field work. (*b*) Metal-cap development engineer, mechanical graduate preferred, with approximately 10 years' experience with metal-cap manufacturer doing development work including production engineering problems on metal caps. Must have this experience. Salaries open. Pennsylvania. W-7318.

Sales Representative, 35–45, graduate engineer. Must know utilities and power-plant stations in New York, N. Y. Salary open. W-7338.

Chief Engineer and Manager having experience in manufacture of both dry-cell and layer-built batteries. Should have ability to train local personnel and be able to get along with workmen. Three-year contract. India. W-7342.

Engineers. (*a*) Plant manager, 35–45, engineering background, with gray-iron foundry experience. Should thoroughly understand cupola practice as well as foundry technique and have actual management experience. About $7500 year. (*b*) Plant engineer, thoroughly experienced, to do all engineering work in connection with plant maintenance and take charge of all development work. Should be competent draftsman and have foundry equipment experience. W-7353.

Junior Mechanical Engineer for general efficiency and operation work in high-pressure steam power plant in medium-sized chemical plant. West Virginia. W-7355.

Welding Engineer able to control machine processes, specify tooling to be used on machines, and able to qualify machine; must be thoroughly familiar with preparation of work before spot-welding, using such welding machines as Sciaky, Taylor Winfield, and Federal. $5000–$6000 year. Also interested in junior welding engineer. About $4000 year. Long Island, N. Y. W-7410.

Design and Installation Engineer experienced in dock and tank foundations and preferably some experience in petroleum industry. Considerable traveling as company has from 30 to 40 marine floating and permanent docks. $5000 year. Headquarters, New York, N. Y. W-7429.

Assistant Superintendent. Must be well-versed in hot steel forging and able to take over correlation of die room and forge shop, reducing operation costs, particularly on die making, die repair, and maintenance. Must inaugurate new methods of making dies, use of new steels, and heat-treatments in die blocks. About $5000 year. Connecticut. W-7434.

Maintenance Engineer, not over 40, with 8 or more years of electrical maintenance experience in industry, to take charge of all electrical work in power plant. Must be capable of changing voltage; plan and see that all work is done on schedule, etc. Any experience in paper mill helpful. Salary open. Massachusetts. W-7437.

Engineers, mechanical, 30–40, to take charge of product development on heating, air conditioning, and refrigeration. May eventually direct engineering work of section or division responsible for development and design of group or products. Factory production and fabrication techniques desirable. Salaries open. Northern New Jersey. W-7466.

Assistant Chief Plant Engineer, 35-45, mechanical graduate, eight to ten years supervisory experience plant maintenance and engineering for similar work. $5000 up, year. Virginia. W-7495.

Research Engineers, assistant, associate or supervisory grades, required for fundamental research on plastics. Work may engage variety of professional talents such as polymer, organic and physical chemists; physicists; mechanical, chemical and electrical engineers. Salary depending upon qualifications. Southern New Jersey. W-7496.

Engineer, mechanical or civil, to act as liaison officer between home office top management and officials at ten plants. Must be thoroughly experienced in construction and plant engineering. $8500 a year. Southern New Jersey. W-7505.

Tool Engineer, preferably General Motors Institute graduate or equivalent with at least 10 years' tool experience for machine-tool manufacturer. Should have thorough knowledge of proper speeds, feeds, and cutting tools for maximum production. Fine opportunity. Apply in writing. Age, 30–40. D-2910.

Engineers. One of largest engine companies located in Midwest engaged in extensive and continuing development program on nonrotating aircraft propulsion engines has openings for the following personnel: (*a*) Development Engineer, mechanical or aeronautical, an idea man with good theoretical and practical background to direct activities of engineering group devoted to preliminary design and analysis. (*b*) Aerodynamicist can use both recent graduates and thoroughly experienced men. Preferably with development experience; must have sound training. (*c*) Physicist, can use recent graduates and thoroughly experienced men. Must have sound training and preferably with development experience. (*d*) Thermodynamicist, research-minded with good theoretical background, advanced degree preferred. (*e*) Vibrations and Structures Engineer with aircraft and aircraft-engine design experience with interest in analytical vibration problems. (*f*) Instrumentation Engineer with good understanding of wind-tunnel instrumentation, familiar with electronic, optical, and other instrumentation means suitable for use in studying aerodynamic and thermodynamic problems. (*g*) Mechanical or Aeronautical Engineers up to 5 years' experience, interested in research and development activity in rapidly expanding program. D-2916.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after April 25, 1946, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

Abell, Roy F., Schenectady, N. Y.
Alcorn, M. C., Los Angeles, Calif.
Ashwood, Paul L., Akron, Ohio
Barnes, Henry Proctor, Detroit, Mich.
Bay, Herbert E., Chicago, Ill.
Belding, Richard L., San Jose, Calif.
Biggs, Fred P., Scarsdale, N. Y.
Bissell, William D., Fall River, Mass.
Bogusz, Walter, Toledo, Ohio
Bonameau, Leo, Beyne, Belgium
Bradford, Leonard R., Waltham, Mass.
Bragar, Norman H., Newark, N. J.
Bulmer, Charlton A., Angola, Ind.
Bunting, Spencer L., Philadelphia, Pa.
Burleigh, Gilbert D., Pittsburgh, Pa.
Caulder, John W., Dayton, Ohio
Chandler, Harold W., Milwaukee, Wis.
Cockrell, Robert W., New York, N. Y.
Collen, Edwin G. P., Litchfield, Conn.
Collins, John T., Orange, N. J.
Cross, Clint, Tulsa, Okla.
Davis, Nelson L., Chicago, Ill.
Demmert, William C., Bloomfield, N. J.
Dodd, Alvin E., New York, N. Y.
Eckler, Norman H., Pittsburgh, Pa.
Eden, Glenn R., Trona, Calif.
Elliott, R. Earl, Baltimore, Md.
Ellis, William G., Dresher, Pa.
Florant, Leroy Fredric, New York, N. Y.
Geiger, Gustav R., Philadelphia, Pa.
Goldstein, Raymond, Bronx, N. Y.
Gross, Charles P. (Maj. Gen.), New York, N. Y.
Hadley, Richard M., Akron, Ohio
Hajduk, Thaddeus, Chicago, Ill.
Harlow, Walter F., Derby, England
Hasselbring, B. H., Riverdale, Md.
Haynes, Charles L., Alhambra, Calif.
Heinrich, H. William, Hartford, Conn.
Henry, John D., Carnegie, Pa.
Hunter, B. J., Portsmouth, Va.
Hussain, S. Khader, Altoona, Pa.
Irving, William M., Needham, Mass.
Johnson, C. H., New York, N. Y. (Rt)
Keller, A. J., Donaldsonville, La. (Rt)
Keller, Harry L., Dawson, Mich.
Lampl, Josef, Los Angeles, Calif.
Large, Charles B., Pasadena, Calif.
Lauterbach, William E., Chicago, Ill.
Lindquist, A. J., Oak Park, Ill.
Little, E. G., Louisville, Ky.
Loeppert, H. Verne, Chicago, Ill.
Lynch, Edmund D., Huntington, Ind.
Marlow, Nicholas, Chicago, Ill.
Martin, Henry A., New York, N. Y.
Masson, E. C., Miami, Fla. (Rt)
Mayster, Sidney, Chicago, Ill.
McComb, Willis M., Bombay, India
Meigs, Charles H. (Comdr.), Arlington, Va.
Miller, Sidney E., West Springfield, Mass.
Muhlberg, T., Brisbane, Queensland, Australia
Muller, H. N., Jr., East Pittsburgh, Pa.
Neuhoff, Malcolm C., Elmira, N. Y.
O'Hagan, James E., Lynwood, Calif.
Penrod, E. B., Lexington, Ky. (Rt & T)
Pepi, Dominic Louis, Boston, Mass.
Peters, Otto H., Syracuse, N. Y.
Peterson, Frank T., Washington, D. C.
Petrie, Eugene C., Elmhurst, Ill.
Potter, Richard C., Chicago, Ill.
Rhodes, James Lewis, New Haven, Conn.
Richard, George R., Drexel Hill, Pa.
Richards, Raymond R., Marlboro, Mass.
Rodth, Joseph J., Westport, Conn.
Rudden, Frank J., Hollis, N. Y.
Russell, D. M., Houston, Texas
Ruth, B. F., Ames, Iowa
Salin, Jarl, Abo, Finland
Setzekorn, Gene M., St. Louis, Mo.
Sevand, A. H. (Capt.), Boston, Mass.
Sheffield, Dale C., Milwaukee, Wis. (Rt & T)
Shutt, James M., Haddonfield, N. J. (Rt & T)
Southcott, A. M., New York, N. Y.
Stack, Robert C. (Maj.), Massena, N. Y.
Steenburn, Abel A., Southbridge, Mass.
Sternberg, Eli, Chicago, Ill.
Stevenson, Frederick Alfred, New York, N. Y.
Stockmann, Henry, Los Angeles, Calif.
Stuckenbruck, Walter, Rio de Janeiro, Brazil
Tetlow, Norman, Cheshire, England
Tuxhorn, D. B., Reading, Pa. (Rt & T)
Warner, Frank W., Jr., Pittsfield, Mass.
Wheeler, W. H., St. Louis, Mo.
Wirtanen, Charles W., Columbus, Ohio (Re)
Wolfe, Harry H., Groveport, Ohio
Yamasaki, Robert M., New York, N. Y.

CHANGE IN GRADING

Transfers to Fellow

Moulton, Clarence F., Omaha, Nebr.
Tenney, Edward H., St. Louis, Mo.

Transfers to Member

Alker, Hayward R., New York, N. Y.
Bessio, Oscar, Washington, D. C.
Bolz, Roger W., Cleveland, Ohio
Coplen, Herman L., Jr., Pasadena, Calif.
Doke, Ernest G., Winnetka, Ill.
Greenberg, Yale J., Winthrop, Mass.
Hobbs, William S., Swarthmore, Pa.
Jones, Rutgers C., New York, N. Y.
Kelkar, A. M., Detroit, Mich.
Maddock, John T., Los Altos, Calif.
Morey, Albert A., Chicago, Ill.
Munro, Robert W., Bala Cynwyd, Pa.
Nelson, Waldemar S., New Orleans, La.
Nobles, Elon John, Scarsdale, N. Y.
Northam, C. D., Chicago, Ill.
Payne, Don I., Glenview, Ill.
Pigage, Leo C., West Lafayette, Ind.
Spalding, F. W., Cincinnati, Ohio
Thomas, R. G., Atlanta, Ga.
White, Henry Packard, Shaker Heights, Ohio

Transfers from Student Member to Junior 50

Necrology

Bronwick, Alexander I., February 25, 1946
Burwell, Arthur W., May 24, 1946
Eldredge, Alfred H., January 26, 1946
Fast, Gustave, May 9, 1946
Halliday, William R., May 24, 1946
Kreisinger, Henry, May 7, 1946
Lamie, Arleigh J., June 16, 1946
Leonard, H. Grant, April 12, 1946
Martone, Arthur, January 13, 1946*
Nesbit, Edwin, April 8, 1946
Whiting, Charles W., May 3, 1946
Van Vechten, George C., March 20, 1946

* Died in line of duty.

A.S.M.E. Transactions for July, 1946

THE July, 1946, issue of the Transactions of the A.S.M.E. contains the following papers:

TECHNICAL PAPERS

- The Supply of Air to Coal-Fired Steam Locomotives, by R. A. Sherman, W. H. Browne, and R. B. Engdahl
- Analysis of Special Electronic-Tube Tests, by J. H. Campbell and C. G. Donsbach
- The Effect of Heat Loss on the Performance of Exchangers With Interconnected Walls, by P. R. Trumpler
- Temperature Uniformity in Heating-Up Processes, by M. P. Heisler
- Dynamic Behavior and Design of Servomechanisms, by G. S. Brown and A. C. Hall
- Conversion of Measurements of Power Output of Diesel Engines to Standard Atmospheric Conditions, by M. A. Elliott
- Water Injection in a Spark-Ignition Engine, by W. P. Green and C. A. Shreeve, Jr.
- Relation Between the Impact and Flexural Tests for Molded Plastics, by L. E. Welch and H. M. Quackenbos, Jr.
- Data From Activity-Recording Instruments Applied to Textile Machinery, by C. S. Parsons

DISCUSSION

- On previously published papers by L. H. Fry; J. D. MacLean; W. M. Rohsenow, M. J. Aronstein, and A. C. Frank; and A. O. Schmidt, O. W. Boston, and W. W. Gilbert